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ENGINEERING:

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VOL. CXVIII.—No. 3061.] *LONDON: FRIDAY, AUGUST 29, 1924.* [*Registered at the General Post Office as a Newspaper.*] [PRICE ... 1s. BY FOREIGN POST 1s. 4d.

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Demonstrator: S. J. Ellis, B.Sc., A.M.I.C.E.
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For detailed syllabus of the Faculty with full particulars of University Regulations, Lecture and Laboratory Courses, Fees, etc., apply to the REGISTRAR. F 444

The University of Sheffield.

SESSION 1924-25.

Vice-Chancellor: SIR HENRY HADOW, C.B.E., D.Mus., LL.D.

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The Courses in the above Departments extend over three or four years and prepare students to become specialists in one or other of these branches of Applied Science.

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The TECHNICAL LABORATORY COURSES commence SEPTEMBER 23rd, 1924.

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The Polytechnic,

309, Regent Street, W.1.

SCHOOL OF ENGINEERING.

President of the School: The Hon. Sir Charles Parsons, K.C.B., M.A., LL.D., D.Sc., F.R.S., &c.
Head of the Department: Alex. R. Horne, O.B.E., B.Sc. (Hons. Eng.), F.R.S. (Edin.), &c.

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Session 1924-25.
(Commencing on Tuesday, 7th October, 1924.)

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TENDERS FOR NEW FIRE FLOAT.

The London County Council invites

Tenders for the Construction

and SUPPLY of a TWIN-SCREW, STEEL FIRE FLOAT, with Internal-Combustion Engines and Centrifugal Fire Pumps, for the river service of the London Fire Brigade.

The Specification, Form of Tender, etc., may be obtained on application to the Chief Officer at the Headquarter's Station of the London Fire Brigade, Southwark Bridge Road, S.E.1, upon payment of the sum of £2, which will be returnable if a *bona fide* Tender is submitted and not subsequently withdrawn. Tenders must be addressed to "The Clerk of the Council," and endorsed "Tender for New Fire Float," and be delivered at the County Hall, Westminster Bridge, S.E.1, not later than Four p.m. on Monday, 6th October, 1924. No Tender will be received after that time. The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
Clerk of the London County Council. F 654

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1. POINT RODS.
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7. TYRES for carriage and wagon wheels.

Tenders due on the 5th September, 1924, for No.1, on the 12th September, 1924, for Nos. 2 to 5, and on the 16th September, 1924, for Nos. 6 and 7.

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Offers are Called for the

PURCHASE as a GOING CONCERN of the ASSETS of the CARBIDE WORKS at ELECTRONA, a deep water port near Hobart, producing approximately 4500 tons per annum which is approximately the total of the Australian demand. Carbide is a virtual monopoly under the Tariff protection and the manufacturing and selling now is by the Receiver under Government auspices. Particulars and details all available from the Hydro Electric Works, expected in London about the 10th September, and will be available for inspection at the Office of the Agent General for Tasmania.

Offers must be addressed to THE AGENT GENERAL FOR TASMANIA, Australia House, Strand, London, W.C. 2, to be received by him up to and including 30th September next. F 659

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THE CLEANSING COMMITTEE OF THE CORPORATION OF LEEDS are prepared to receive

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J. B. HAMILTON,
Commercial Manager.

Swinegate,
LEEDS. F 691

COUNTY BOROUGH OF SOUTHAMPTON.
RECONSTRUCTION OF COBDEN BRIDGE IN STEEL.

Tenders are Invited for the

RECONSTRUCTION of the above mentioned BRIDGE, having five spans of about 75 ft. each including the provision of a temporary bridge, approaches and all incidental works.

Drawings of the proposed works can be seen at the office of the Engineer of the work, Mr. H. W. FitzSimons, B.Sc., M.Inst.C.E., 39, Victoria Street, Westminster. Copies of the Specification, Bill of Quantities and Form of Tender are to be obtained from the Engineer's Office on payment of Five Guineas, which sum will be returned upon receipt of a *bona-fide* Tender and the return of all documents.

Sealed Tenders, endorsed "Cobden Bridge, Steel," must be sent to the Town Clerk, Southampton, not later than Ten o'clock in the forenoon on Monday, the 15th day of September, 1924.

The Corporation do not undertake to accept either the lowest or any Tender.

R. R. LINTHORNE,
Town Clerk.

25th August, 1924. F 681

COUNTY BOROUGH OF SOUTHAMPTON.
RECONSTRUCTION OF COBDEN BRIDGE IN REINFORCED CONCRETE.

Tenders are Invited for the

RECONSTRUCTION of the above-mentioned BRIDGE having five spans of about 75 ft. each including the provision of a temporary bridge, approaches and all incidental works.

Drawings of the proposed works can be seen at the office of the Engineer for the work, Mr. H. W. FitzSimons, B.Sc., M.Inst.C.E., 39, Victoria Street, Westminster. Copies of the Specification, Bill of Quantities and Form of Tender are to be obtained from the Engineer's Office on payment of Five Guineas, which will be returned on receipt of a *bona fide* Tender and return of all documents.

Sealed Tenders, endorsed "Cobden Bridge, Concrete," must be sent to the Town Clerk, Southampton, not later than Ten o'clock in the forenoon on Monday, the 15th day of September, 1924.

The Corporation do not undertake to accept either the lowest or any Tender.

R. R. LINTHORNE,
Town Clerk.

25th August, 1924. F 682

STATE ELECTRICITY COMMISSION OF VICTORIA.
Melbourne,
Victoria,
AUSTRALIA.

Tenders are Hereby

Invited for the SUPPLY, DELIVERY, etc., of the following for the Yallourn Power Scheme.

Copies of Tender Form and Specification will be available upon application to:—

AGENT-GENERAL FOR VICTORIA,
Melbourne Place, Strand,
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SPECIFICATION No. 24/88—

66,000 VOLT TRANSFORMERS, INDUCTION REGULATORS AND ACCESSORIES.

CHARGE:—£2 2s. for the first three copies of Tender Form, Conditions of Contract and Specification complete. This charge will be returned on receipt of a *bona fide* Tender. A fourth copy, and any further copies, will be supplied for the sum of 10s. 6d. each. This charge is not returnable.

PRELIMINARY DEPOSIT:—A Preliminary Deposit of £100 is to be lodged with Tender.

The Specifications may be inspected at the above-mentioned office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than Five p.m., 1st December, 1924.

R. LIDDELOW,
Secretary. F 702

METROPOLITAN BOROUGH OF ST. PANCRAS.

ELECTRICITY DEPARTMENT.

Tenders are Invited for the

STRUCTURAL STEELWORK required for BOILER HOUSE EXTENSIONS. Specifications and Drawings can be obtained at the Offices, 57, Pratt Street, London, N.W.1, on the payment of £2, which is returnable on receipt of a *bona fide* Tender.

Tenders to be sent in on or before Tuesday, 9th September, 1924.

The Council do not bind themselves to accept the lowest or any Tender.

C. H. F. BARRETT,
Town Clerk.

Town Hall,
Pancras Road,
London, N.W.1. F 709

PORT OF BRISTOL.

GRAB HOPPER DREDGER.

The Docks Committee invite

Tenders for the Construction,

DELIVERY and MAINTENANCE of a GRAB HOPPER DREDGER, with a hopper capacity of 18,000 cu. ft.

N.B. The Grab Cranes themselves are not included in the Contract.

On and after Monday the 8th day of September, 1924, copies of the Specification, etc., can be obtained from the undersigned on production of a receipt to the undersigned, showing that a deposit of £5 has been paid to the Bristol Docks Committee, to whom all cheques must be sent and made payable. The deposit will be returned to *bona fide* Tenderers after the receipt of the Tenders with all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope, endorsed "Tender for Grab Hopper Dredger," and addressed to the General Manager and Secretary of the Docks Committee, 19, Queen Square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings, before Ten a.m. on Monday, the 20th day of October, 1924.

The Docks Committee do not bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Chief Engineer.

Chief Engineer's Office,
Avonmouth Dock,
Bristol.
27th August, 1924. F 719

THE JOINT COMMITTEE OF THE
COUNTY COUNCIL OF LANARK;
TOWN COUNCIL OF THE BURGH OF HAMILTON; and
TOWN COUNCIL OF THE BURGH OF MOTHERWELL AND WISHAW,
CLYDE BRIDGE, HAMILTON.

The Joint Committee are prepared to receive

Tenders for the Construction

of a Bridge, about 360 feet in length and 80 feet in width, of independent steel-girder spans supported on piers or columns, with exposed facework of masonry, for carry the public highway leading between Hamilton and Motherwell across the River Clyde, at a point about 120 yards below the present Clyde Bridge. Tenderers will require to submit their own designs.

The Tender will not include the construction of the roadway forming the approach to the Bridge.

Drawings, showing the data to which Tenders and Drawings submitted relative thereto are required to conform, may be inspected, and specifications and forms of Tender obtained on and after 1st September, 1924, on application being made to Messrs. Formans & McCall, C.E., 160, Hope Street, Glasgow. Early application is desirable and no specification will be given out after 30th September, 1924.

For each Specification a deposit of £1 1s. will be required, which sum will be returned to the Tenderer provided that he shall have sent in a *bona fide* Tender based on the Drawings and specification, provided with a Schedule of Quantities fully priced out in detail, and shall not have withdrawn same. If Contractors desire to obtain a set of drawings these will be supplied by Messrs. Formans & McCall at a charge of half a guinea per set.

The employment of labour shall be in accordance with the revised conditions of the Unemployment Grants Committee.

Tenders on the Forms prescribed, together with relative design and other documents as provided for in the specification, to be enclosed in a securely sealed envelope endorsed "Tender for Clyde Bridge, Hamilton," and must be lodged with the subscribers not later than Ten o'clock a.m. on the 31st day of December, 1924.

The Joint Committee do not bind themselves to accept the lowest or any Tender.

J. McGHIE,
ROBERT BRYCE WALKER,
County Clerks.

County Offices,
Hamilton, 25th August, 1924. F 693

APPOINTMENTS OPEN.

WOOLWICH POLYTECHNIC.

Lecturer Required, Engi-

neering Department. Graduate with teaching, works, and drawing office experience, to teach engineering science and drawing, and to lecture on workshop processes. Salary according to Burnham scale. Particulars from PRINCIPAL. F 667

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON, S.W.7.

Applications are Invited for

the POST of DEMONSTRATOR in the Mathematics and Mechanics Department of the Royal College of Science (some engineering experience essential), salary £300 per annum. Full particulars on application.—Candidates' applications, addressed to the SECRETARY at the College, must be received not later than 5th September, 1924. F 646

THE POLYTECHNIC,
REGENT STREET, W.1.
SCHOOL OF ENGINEERING.

The Services of a Visiting

LECTURER in the subject of "Drawings, Specifications and Quantities," with special reference to Civil Engineering, are REQUIRED on Tuesday evenings from 8.0 to 9.30 throughout the session, which begins on September 26th, 1924. Salary 18s. 4d. per visit.—Applications, with testimonials, to be sent to the DIRECTOR OF EDUCATION, not later than September 8th. F 639

ROADS ENGINEERS.

Wanted for Road Schemes, under Local Highway Authorities in Great Britain, a number of TEMPORARY ENGINEERS, ASSISTANT ENGINEERS, and JUNIOR ENGINEERING ASSISTANTS for temporary employment. Inclusive salaries, within following limits, according to works, experience, and qualifications:—

Engineers	£500 to £700.
Assistant Engineers ...	£300 to £400.
Junior Engineering Assistants	£150 to £200.

Preference will be given to men who have served in His Majesty's Forces.

Applications should be made immediately, in writing, to the ESTABLISHMENT OFFICER, Ministry of Transport, 6, Whitehall Gardens, S.W. 1, stating age, qualifications, experience, references, and in which district employment would be preferred. F 692

THE MUNCIPALITY OF SINGAPORE.

STRAITS SETTLEMENTS.

SUPERINTENDENT OF FITTINGS—GAS DEPARTMENT.

The Municipal Commissioners of Singapore require a

Superintendent of Fittings for the Gas Department, age about 25, well educated, of sound constitution, and unmarried. Candidates must have a good practical knowledge of gas fittings, main and service laying, and general district maintenance work. The selected candidate must be of good education and address, as the Muncipality lay on all services, together with internal fittings to private buildings, and the person appointed will come into contact daily with consumers, in case of complaints or new fittings, etc., whose requirements he will be expected to satisfy. Preference will be given to an experienced candidate who has been employed as a District Inspector, and the duties are those usually carried out by a Superintendent of Fittings. The selected candidate would work directly under the instructions of an Assistant Gas Engineer in charge of District work. The appointment will be on agreement for three years with possible extension. The selected candidate must pass a medical examination as to his fitness for service in Singapore. A passage will be provided with half-salary during the voyage out. The salary will be 4560 dollars for the first, 5040 dollars for the second, and 5520 dollars for the third year, paid monthly, the value of the dollar being two shillings and four pence sterling. For the first year the salary would be equal to £532 as above, with an allowance for such transport as may be required on duty.—Applications, stating age, place of birth, and giving details of education, training, and experience generally, stating when free, accompanied by copies (only) of testimonials, and also personal references, to be lodged with Messrs. C. C. LINDSAY & PEIRCE, M.M.Inst.C.E., 180, Hope Street, Glasgow, Agents to the Municipal Commissioners (from whom further information may be obtained), not later than Tuesday, 2nd September, 1924. F 612

The Royal Air Force REQUIRES ELECTRICIANS, ELECTRICAL FITTERS, ENGINE DRIVER FITTERS, POWER STATION ENGINEERS and WIRELESS OPERATORS. Age limits 18 to 30. Pay from 24/6d. to 38/6d. per week, on enlistment, and all found. Allowance for wife and children to men 26 and over.—Write, stating age, or call, INSPECTOR OF RECRUITING, R.A.F., 4, Henrietta Street, Covent Garden, London, W.C.2. F 214

Responsible Position Abroad shortly VACANT for man with all-round knowledge of machine tools and first-class commercial experience. Knowledge of Railway Works practice essential.—Applicants should reply by letter with full details of qualifications and remuneration required, to the CHAIRMAN, Associated British Machine Tool Makers Ltd., 17, Grosvenor Gardens, London, S.W.1. F 668

Company Operating in East Africa, REQUIRES an ENGINEER with good knowledge of Marine Type Oil Engines 40-100 H.P. and with some experience on erection of machinery.

Salary about £360 per annum with one servant allowance and free quarters.

Passage out and home. Three years' agreement.—Address, sending copies only of testimonials, which will not be returned, F 683, Offices of ENGINEERING.

Mechanical Engineer Re- QUIRED for Gold Mine in Colombia, S.A., with workshop training, and experienced in construction and operating gold milling plant. A knowledge of Spanish desirable.

Reply by letter stating age, experience and salary required to BOX 3626, THE E.C. ADVERTISING CO., LTD., 4, Broad Street Place, E.C. 2. F 700

Engineers and Millwrights.— WANTED for Cotton Ginning Factories in British East Africa, YOUNG ENGINEER, age about 24 to 28 years, with good all round knowledge of general engineering and familiar with Gas-Producer and Steam Engines; able to carry out general overhauls and repairs without supervision, assisted by unskilled native labour. Three years' engagement, free quarters, passages paid out and home.—Write, stating particulars of experience and where gained, age and wages expected, to H.K., c/o J. W. VICKERS & Co., LTD., 5, Nicholas Lane, E.C. 4. F 706

Overseer Required by the GOVERNMENT of HONG KONG, for the PUBLIC WORKS DEPARTMENT, for three years, with possible extension. Salary £320-£10-£360 a year, payable locally in dollars at the Government rate of exchange—at present fixed at 2s. to the dollar. In addition a strictly temporary exchange allowance is at present paid amounting to 20 per cent of salary. Free passages and quarters. Candidates, aged 25-35, must have had experience as clerk of works or foreman of works on the construction of quay walls, jetties or wharves in stone and/or concrete and must be able to read plans and make measurement of completed work.—Apply at once, by letter, stating age and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W.1, quoting at head of letter M/12608. F 718

Testing

A Monthly International Journal Devoted to the Field of Testing Materials, Structures and Machinery.

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Subscription, $15.00 per Annum

PULLMAN PUBLISHING COMPANY

Pullman Building, Madison Square Station NEW YORK, U.S.A.

Required, First-class Colliery MANAGER. Must have good experience in sinking and opening out pit bottom, also in electric haulage, pumping, and conveyor work.—Apply in writing, stating full particulars as to age, experience, references, etc., to PEARSON & DORMAN LONG LTD., 19, Victoria Street, Westminster, S.W.1. F 686

Wanted Manager for an Indian Colliery (Bengal) with first-class certificate, must have held manager's position. Five years' agreement, good prospects for suitable man. Salary commencing at the equivalent of £360 per annum, plus allowance and free house in healthy district.—Write with full particulars of experience, age, etc., to Z.Z. 333, c/o DEACONS Advertisement Agency, Leadenhall Street, London, E.C. 3. F 662

Works Manager Required for works near London. Applications will only be considered from Britishers with considerable experience in similar positions, holding the highest credentials and having preferably practical experience with blast furnaces, lime kilns, and grinding and conveying plant, with knowledge of works chemistry, and capable of taking entire control of personnel, output and maintenance. Permanent job with commencing salary of £500 p.a. Applicants should state concisely their previous experience, with dates.—Address, F 562, Offices of ENGINEERING.

Cost and Estimating Clerk REQUIRED at once for Office in Westminster. Experience of road construction essential (Asphalte experience preferred).— Address, by letter only, stating age, experience and salary required, F 656, Offices of ENGINEERING.

Salesman.—One of the Oldest firms in the London Lubricating Oil Trade, having provincial branches, REQUIRES a COMPETENT SALESMAN, having a knowledge of the Trade.—Write Z P., MAY'S, 24, Bury St., S.W.1. F 685

Two First-class Steelwork ERECTORS REQUIRED for Calcutta. Applicants should have had good experience in connection with the erection of large steel frame buildings. The contract will be for twelve months in the first instance, with possibility of an extension for three years later.—Apply, stating salary required, age, and giving an outline of experience and copies of recent testimonials, to GENERAL MANAGER, BRAITHWAITE & Co., Engineers, Ltd. Crown Bridge Works, West Bromwich. F 679

A Vacancy Exists at the ROYAL AIRCRAFT ESTABLISHMENT for a TECHNICAL ASSISTANT in work relating to aircraft engine research. Candidates must have works and design experience and technical training to the standard of engineering degree, also a good knowledge of mathematics and physics and ability to apply it to engine problems. Salary £250-£350 plus C.S.B., giving present total of £317-£504.

Ex-service men preferred.—Apply, quoting A.37 to the SUPERINTENDENT, R.A.E., South Farnborough, Hants. F 720

COUNTY OF DURHAM.

APPOINTMENT OF COUNTY SURVEYOR, ENGINEER AND ARCHITECT.

The County Council of Durham are prepared to receive

Applications for the Position of COUNTY SURVEYOR, ENGINEER and ARCHITECT.

The person appointed will be required to devote the whole of his time to the duties of the Office and will not be permitted to undertake any other business. The Salary will be at the rate of £1400 per annum, rising by annual increments of £100, subject to satisfactory service, to £1,700 per annum.

The appointment will be subject to three calendar months' notice on either side.

Applicants must have special qualifications as to the construction of roads and bridges, and preference will be given to those who are under the age of 45 and who are Corporate Members of the Institution of Civil Engineers.

The appointment is a Designated Post under the Local Government and other Officers Superannuation Act, 1922, which has been adopted by the County Council, and the person appointed will be subject to the provisions of such Act.

All offices, staff, stationery etc., will be provided by the County Council.

Applications, endorsed "County Surveyor," together with copies of not less than three recent testimonials to be sent to the undersigned, not later than Wednesday, the 17th September, 1924, from whom a statement of the duties and conditions of the office may be obtained.

Canvassing will be deemed a disqualification.

By Order,
HAROLD JEVONS,
Clerk of the County Council.

Shire Hall,
Durham,
15th August, 1924. F 696

Required for Argentine Rail- way, CHIEF DRAUGHTSMAN, Way and Works Department. Commencing salary £600 per annum. Age 32/35.—Applications, giving full particulars of training, experience, age, etc., to be sent with copies (only) of testimonials, to BOX S.A., c/o DAVIES & Co., 95, Bishopsgate, E.C. 2. F 677

Capable, Experienced, Mech- ANICAL Engineer (27), Wide Business, Commercial experience. Works Manager of Machine Fitting, Gear Cutting works. Sound Motor Engineering knowledge. Drawings. Estimates. Correspondence, Interviewing. Desires good Post requiring keen worker, energy, ability. FIRST CLASS education, references.—Address, V.N.M. "Craigie," Bretby Lane, Burton-on-Trent. F 713

Chief Draughtsman Wanted for London Works at once, one accustomed to Boiler work jacketted pans, Buoys, Stills and all kinds of pressure work. State experience, salary required and full particulars.—Address, F 680, Offices of ENGINEERING.

Expert Press-Tool Maker REQUIRED for North East Coast, to make large compound dies for electrical stampings.—Address, giving full particulars of experience and wages required, F 607, Offices of ENGINEERING.

Senior Draughtsman for established firm Motor Manufacturers near London. Must be experienced in design of chassis components and all technical calculations connected therewith, accurate and reliable. Also juniors for similar class of work.—Address, stating age, giving full particulars and experience, F 654, Offices of ENGINEERING.

Senior Draughtsman.—Wanted by firm in West London District first-class Senior Draughtsman for work on Aero Engine design.—Address, giving full particulars of past experience and salary required, F 707, Offices of ENGINEERING.

Leading Draughtsman REQUIRED, thoroughly experienced in Aerial Ropeways.—Address, full details of experience, age and salary, F 689, Offices of ENGINEERING.

Wanted by Contracting Engineers in London, for design of all classes of handling plants, ONE or TWO LEADING DRAUGHTSMEN, with really first-class mechanical and structural experience. Permanency for suitable men. State age, experience and salary required.—Address, F 669, Offices of ENGINEERING.

Required, for London District, EXPERIENCED DRAUGHTSMAN for structural Steelwork able to take charge of Contracts throughout. State age, experience, qualifications and salary required.—Address, F 667, Offices of ENGINEERING.

Wanted, Good Draughtsman for Designing and Estimating Department.—Apply, by letter only, stating age, experience and salary required, to JOHN BUTLER & CO. LIMITED, Stanningley Ironworks, Nr. Leeds. F 698

Structural Draughtsman WANTED immediately. Used to Coal Screening and Sorting Plants, Pit Head Gears, etc. None but experienced men need apply.—Address, giving full particulars, F 671, Offices of ENGINEERING.

Junior Draughtsman Wanted, used to Centrifugal Pumps.—BLACKSTONE AND CO., Stamford. F 673

Junior Draughtsman Required with knowledge automobile engine design. £3 10s. salary.—Address, F 676, Offices of ENGINEERING.

Junior Draughtsman REQUIRED, experienced in general mechanical work.—Address, stating age and experience, with copies of testimonials, F 690, Offices of ENGINEERING.

SITUATIONS WANTED.

A M.I.M.E. (Exam.), Inter. B.Sc. (Eng.), etc., 24, Desires Post with prospects and some responsibility, 7½ years' experience, 4 years D.O.; salary unimportant.—Address, F 658, Offices of ENGINEERING.

A M.I.C.E., 33, Railway & Locomotive Works and D.O. trained. Several years District Locomotive Superintendent, wide experience automobile, hydraulic and general engineering, also commercial, used to control of large staffs. Desires Progressive Post where initiative and varied experience are needed. Moderate salary.—Address, F 645, Offices of ENGINEERING.

Quarry Manager, will Shortly be at liberty. Conversant in up-to-date Quarrying Methods. Haulage, Crushing, Screwing, Gas Fired Kilns, Tar Macadam and Co., control of men and Plant maintenance.—Address, F 655, Offices of ENGINEERING.

Tool Room Superintendent Seeks Engagement as Assistant Works Manager. Public school, engineering and commercial training. Experienced in control of men. Knowledge of France and Italy. Age 32.—Address, F 716, Offices of ENGINEERING.

Advertiser Requires Appoint- MENT Accountant Engineering Co., over 20 years last berth. Excellent references.—Address F 710, Offices of ENGINEERING.

Steel and Iron Foundry Manager Desires Change. Ten years' successful management. Experienced Siemens, Tropenas, and full control of personnel. Would reorganize, erect plant or advise with a view to management. South of England preferred.—Address, F 714, Offices of ENGINEERING.

Youth, 19, Seeks Situation Engineer's office; 4 yrs. workshop experience. Knowledge machine drawing. Moderate wage.—NICHOLLS, 15, Tonsley Road, S.W.18. F 715

Engineer (Mechanical and Electrical), Age 29, SEEKS Responsible APPOINTMENT in Power Company. Wide experience with Water and Fire Tube Boilers, Fuel Oil, Reciprocating and Turbine Engines, High and Low Tension Supply, etc. B.O.T. Certificate. 7 years' sea experience.—F 694, Offices of ENGINEERING.

Superintendent.—Punch Press, and Die Casting Specialist, REQUIRES POSITION, with real live concern. Latest methods of design and manufacture. Last position held 3½ years, General Motors Corporation, U.S.A. English.—Address, F 670, Offices of ENGINEERING.

Skilled Mechanic Seeks Situation, 23 years' experience precision work, bench and machines, experimental, electrical, good all round, excellent references.—Address, F 634, Offices of ENGINEERING.

WORK WANTED.

J. Kirkaldy, Limited. WORKS: BURNT MILL, ESSEX. 2325

We are organised to produce castings from 2 lbs. to 2 tons. Cast-iron, Semi-steel, and Non-ferrous castings. Coils of every description, Steel and Copper. Sheet Metal Work. Over 40 years' experience is at your service. Send your enquiries along.

WANTED, &c.

Engineer Desires to Represent in LONDON, a firm who require their interests energetically and wholeheartedly pressed. Remuneration on results only.—Address, F 653, Offices of ENGINEERING.

Consulting Engineer, A.M.I.C.E., with experience as Head Draughtsman and Works Manager, acquiring larger offices, is OPEN to REPRESENT One or Two Enterprising COMPANIES of high repute, to handle enquiries and technical correspondence for London District.—Address, F 625, Offices of ENGINEERING.

India, Burmah and Ceylon.— Experienced Traveller (Practical Engineer), with old and influential business connections, OFFERS at moderate cost to REPRESENT additional FIRM of repute during extensive tour.—Address, F 699, Offices of ENGINEERING.

The Proprietors of Patent No. 7347 of 1915, for "Improvements in Apparatus for the Manufacture of Bottles and similar Glassware," are DESIROUS of ENTERING into ARRANGEMENTS by way of licence and otherwise on reasonable terms for purpose of exploiting same and ensuring its full development and practical working in this country.—Address all communications in first instance to HASELTINE, LAKE & CO., Chartered Patent Agents, 28, Southampton Buildings, Chancery Lane, W.C. 2. F 687

Agents Wanted.

Established Engineering Firm, specialising in Automatical Force Feed Lubricators for every type of machine, intends to appoint agents in every country, Europe and abroad, on generous commission terms. Applications from engineers with sound connections to the machine tradeand motor-factories, should contain age, references, photo and limits of agency-district.—Address, GEWO, Muenchen 25 (Germany). F 678

Important French Joint-Stock Company, having its seat in Paris, owning several Mechanical Workshops, Foundry, Forging and Stamping Shop, Storehouses, equipped with modern machinery, all of approved type, WISHES to ESTABLISH CONNECTION with BRITISH FIRM, with a view to agreement, collaboration or association, to undertake in France the manufacture of British products for the French Market.—Address, F 717, Offices of ENGINEERING.

Wanted, Belt-Driven Single Stage AIR COMPRESSOR, delivery 50 cubic feet of air per minute at 100 lbs. pressure sq. in. minimum. State makers No. and price.—Address, F 675, Offices of ENGINEERING.

Copy of Engineering, 19th January, 1912, with plates, WANTED for purchase or loan.—Write, ANDERSON HODGES, 38, Victoria Street, S.W. F 713

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IF YOU ARE SEEKING

A Partner or Partnership

or wish to Buy or Sell a BUSINESS OR WORKS Write:—

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ESTABLISHED OVER SEVENTY YEARS. 1675

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To Boiler Buyers.— Vertical, Loco., Cornish, Launch, Field Tube. Air Receivers & Feed-water Heaters.—GRANTHAM BOILER & CRANK Co., LD., Grantham.

Bankrupt Stock.—Brand New High Speed Taper Shank TWIST DRILLS, 1 in. to 2¼ in. dia.

30 per cent. off SHEFFIELD LIST.

GREGORY & SUTCLIFFE, Viaduct Street, Huddersfield. F 708

For Sale, &c., continued on page 4.

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Lancashire Dynamo Co., Ltd., 1920, Comprising, 480 volt, D.C. Motor, coupled to 165 volt, 520 ampere compound-interpole Generator, complete with Switchboard.

THE PHŒNIX ELECTRICAL CO., LTD., 17, Oswald Street, Glasgow. C 475

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The Opportunity Arises to

PURCHASE a sound BUSINESS in the above Trade, established for over 100 years, situate in London close to the Docks, Contractors to Admiralty, War Office and other Government Departments.

Freehold and Leasehold Premises, well equipped with machinery for carrying on the work.

Principals only can obtain further information by appointment with Messrs. BRADSHAW, BROWN AND CO., Auctioneers and Engineers' Valuers, Billiter Square Buildings, London, E.C. 3. F 697

TO COPPERSMITHS AND BRASS FOUNDERS.

To be Sold, Freehold

WORKS covering an area of about 15,000 ft. super with substantial buildings erected thereon, together with the Goodwill of the old established business situate in London, close to the Docks, with necessary plant and machinery, as a "GOING CONCERN."—Apply, BRADSHAW, BROWN AND CO., Auctioneers and Engineers' Valuers, Billiter Square Buildings, London, E.C. 3. F 696

2-500 Kw., 500/550 Volt D.C.

GENERATING SETS, Totally Enclosed, Three Crank Self-Lubricating Engine, with Complete Condensing Plant, by Allens, Pipes, Valves, Oil Separator, Etc. complete.

Admirably suited for Mining or other power transmission work.

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Newcastle-on-Tyne. 1701

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of London, FREEHOLD ENGINEERING WORKS, including Iron, Brass & Aluminium Foundry and Large Quantity of Machinery. Works cover an area of approximately 13,400 sq. ft.—Apply CHANTREY, BUTTON & CO., 61-63, Lincoln's Inn Fields, London, W.C.2. F 709

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HYDRAULIC ACCUMULATOR, by Leeds Engineering and Hydraulic Co. Ram 15 in. dia. by 20 ft. Stroke. Working pressure 1500 pounds per square inch. Built 1916. Guaranteed in first-class working order. Will accept low figure for quick sale.—GEO. COHEN SONS & CO. LTD., 600, Commercial Road, London, E.14. F 701

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'Phone: 860 (8 lines). COVENTRY, Wires: Lathes, Coventry.

Machine Tool Bargains.

You are cordially invited to inspect the large stocks of NEW, RE-CONDITIONED and SECOND-HAND machines which we are offering at specially REDUCED PRICES from our Coventry Warehouses. The following is a selection :—

BORING MACHINES.

40 in. Webster & Bennett Duplex Boring Mill, two 40 in. tables, belt drive from C'shaft with separate gear box and clutch. (SECOND-HAND.)

60 in. Gisholt Vertical Boring and Turning Mill with two swivel heads, quick change gear box and rapid power traverse, arranged for motor drive. (SECOND-HAND.)

2½ in. Dickinson Hor. Boring, Drilling, Tapping and Milling Machines, S.P. Gear Box Drive, with swivelling square table, boring bar and facing head. (RE-CONDITIONED).

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6 ft. 0 in. McKendrick Girder Type Radial Drill, arranged for single speed motor drive, minus motor. (NEW.)

Alfred Herbert Single Spindle B.B. Drill, with automatic feed, pump and fittings. (RE-CONDITIONED.)

26 in. American Tool Works Upright Sliding Head Drill, C.P. drive, auto feed, 2-speed S/C c'shaft, and 18 in. by 48 in. Rectangular Table. (SECOND-HAND.)

GRINDING MACHINES.

No. 2 12 in. by 30 in. Morse Plain Grinder with pump and c'shaft. (RE-CONDITIONED.)

No. 3 12 in. by 42 in. Landis Universal Grinder with c'shaft and full equipment. (RE-CONDITIONED.)

No. 4 Van Norman Internal Grinder with auto feed to table, power cross feed and water attachment, 3-jaw chuck, Cap. : 9½ in. dia. by 6 in. deep. (NEW.)

LATHES. (CENTRE).

5½ in. by 5 ft. 0 in. Atkins S.S. & Sc. Lathe, C.P., B.G. with 3-speed c'shaft, travelling and stationary steady rests, 1 in. hole through spindle, admits 2 ft. 7 in. between centres. (NEW.)

8 in. by 10 ft. 0 in. Lodge & Shipley S.S. & Sc. Lathe, C.P., B.G., Q.C. with c'shaft, 3-point steady rest and faceplate, 1½ in. hole through spindle, admits 6 ft. 5 in. between centres. (RE-CONDITIONED.)

6½ in. by 6 ft. 9 in. Willard S.S. & Sc. Lathe, C.P., D.B.G., Q.C., 1½ in. hole through spindle, admits 3 ft. 3 in. between centres. (RE-CONDITIONED.)

MILLING MACHINES.

No. 1 Garvin Universal Mill, B.G., with Universal Dividing Head and standard equipment, Cap. : 22 in. by 8 in. by 18 in. (NEW.)

No. 3 Cincinnati Plain Mill, C.P., D.B.G., complete with arbor, two arbor supports, double friction c'shaft, pump and fittings, Cap. : 34 in. by 9 in. by 20 in. (RE-CONDITIONED.)

No. 50 Becker Vertical Spindle Mills, with constant speed drive, Cap. : 54 in. by 16 in. by 18 in. (SECOND-HAND.)

MISCELLANEOUS.

No. 2 Garvin Horizontal Tapping Machine with ¼ in. chuck and plain c'shaft, Cap. : ⅛ in. to ¼ in. (NEW.)

No. 2 Mitts & Merrill Keyseater with Cutter Bars, two work arbors, four adaptors, one clamp and c'shaft. (RE-CONDITIONED.)

3000 Kilos. Derihon Ball Hardness Testing Machine, hand driven with separate wall attachment for power operation. (RE-CONDITIONED.)

ASK FOR SURPLUS LIST NO. 11—IT WILL PAY YOU. F 663

Air Compressors (Three) to

3000 lbs. per sq. in. Two by Luth & Rosens, driven by 88 HP., D.C. Motors, 230 volts, and one FOUR STAGE Ditto, driven by Motor 85 HP., 230 Volts. In very good condition and very low in price Could be sold separate from Motors.

JENNINGS,
West Walls, Newcastle-on-Tyne. F 649

1000 Kilowatt — Parsons

TURBINE SETS—230 Volts, D.C., with Condensing Plant complete, good condition—spare armature.

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West Walls, Newcastle-on-Tyne. F 650

Diesel Engines.—The

following are FOR IMMEDIATE DISPOSAL at about one-fourth usual prices.

Two—1200 HP. by Krupp, 2 stroke, 6 cylinder.
One—1000 HP. " " 4 " "
Two— 800 HP. " " 4 " "
Also D.C. DYNAMOS for above 230 and 500 Volts.

JENNINGS,
West Walls, Newcastle-on-Tyne. F 651

Exhaust Turbine Generating

SET 600 Kw., BRUSH-PARSONS, 230 Volts, D.C., with full surface condensing plant, valves, piping, oil separator, etc. Excellent condition and very low price.—

JENNINGS,
West Walls, Newcastle-on-Tyne. F 659

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Nos. 139414 and 140004 relating to "Improvements in Hydraulic Turbines," are DESIROUS of getting the INVENTION TAKEN UP in Gt. Britain, either by Sale of the Patents or by the grant of a licence or licences to manufacture on royalty.—Enquiries to be addressed to Messrs. ABEL AND IMRAY, 30, Southampton Buildings, London, W.C.2. F 603

The Proprietors of Patent

No. 128639, for "Improvements in or relating to Automobile Tractors," are DESIROUS of ENTERING into ARRANGEMENTS by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country.—Address all communications to, HASELTINE LAKE & CO., Chartered Patent Agents, 28, Southampton Buildings, Chancery Lane, W.C.2. F 608

Govan Engine Works,

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FOR SALE
IN WHOLE OR PLOTS.

GROUND extending to 42,672 square yards, and BUILDINGS thereon of Engine and Boiler Shops (lately belonging to Messrs. DUNSMUIR & JACKSON, Ltd.), equipped with Overhead Travelling Cranes up to 60 tons.

For particulars apply—
WEARING & MARTIN,
Writers,
180, Hope Street, Glasgow.

2346

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1½ in. Double-ended Punching and Shearing Machine, with Angle Cutter Cam and lever motion. Shearing Gap 2 ft. 6 in., Punch Gap 3 ft., with 2 Swing Cranes attached, 13 ft. radius, each, having set of 3-ton "Thomson" Lifting Blocks attached, direct driven by Motor and Starter.

Hydraulic Flanging Press with Vertical Ram 10 in. diameter, for flattening process, Vertical Ram 10 in. diameter, for flanging process, and Horizontal Ram 7 in. diameter, flanging process, with drawback cylinders to each motion, complete with Valves and Piping. By Tweedells, Gloucester.

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135 HP. Robey Cross Compound Drop Valve STEAM ENGINE.

140 H.P. Garratt Superheated STEAM ENGINE and BOILER with all accessories.

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Electric Generating Plant for

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Direct Current.

Two	26 Kw.	105 Volts.	"Howden-B.H.E."
Two	52 "	" "	"Brotherhood - Laurence Scott."
Two	100 "	440/580 "	Gerrett Semi-Portable.
One	120 "	110 "	"Belliss-Siemens."
One	150 "	220 "	"Howden-Lane, Dynamo.
Two	200 "	" "	"W. H. ALLEN."
Two	200 "	" "	"Belliss-Siemens."
One	240 "	440/500 "	"Belliss-Phœnix Dynamo.
One	375 "	250 "	"Allen-Westinghouse."
One	400 "	240 "	"Howden-Siemens."
One	500 "	230 "	"Howden-B.T.H."
One	500 "	230 "	"Belliss-B.T.H."
One	500 "	500 "	Metropolitan Vickers Turbo.
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One	750 "	220 "	"Parsons-Crompton" Geared Turbo.
One	1250 "	250 "	"Belliss" Turbo.

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One	400 Kw.	550/550 Volts.	"Howden-G.E.C."
One	750 "	" "	"Metropolitan Vickers."
One	850 "	" "	"Fraser & Chalmers."
Two	1000 "	" "	"Metropolitan-Vickers."
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One	2000 "	500/550 "	" "
One	3000 "	6600 "	"B.T.H."

All above are modern, and condensing plant is available in nearly all cases.

We can also offer several Suction Gas and Diesel Sets, Babcock Boilers up to 30,000 lbs. per hour, and a very large number of motors, generators, Motor-generators, rotary converters, etc.

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Two Nearly New Tangye's MOTOR 'BUS TYRE PRESSES, to give a pressure of 60 tons, ram, 7 in. diameter, 24 in. run out.

Two 2 ft. gauge 4—6—0 SIDE TANK LOCOMOTIVES (Baldwins), new 1917, cyls. 9 in. by 12 in., suitable 175 lbs. pressure; ready for work.

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One 2 ft. gauge PETROL LOCOMOTIVE, 15-h.p.; new condition; Coventry Simplex engine, Simms high-tension mag., Zenith carburettor; a first-class loco., ready immediate work.

Two 12-ton "WILSON" LOCO. STEAM CRANES, with 27 ft. jibs; 4 ft. 8½ in. and 8 ft. 3 in. gauges; suitable 90 lbs. pressure.

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SHERARDISING; ITS INCEPTION AND DEVELOPMENT.

By Sherard Cowper-Coles.

The process of Sherardising, or vapour galvanizing, was discovered in the year 1900, and consists of heating the metal to be coated with zinc in a closed receptacle with zinc dust to a temperature of about 600 deg. F., a temperature below the melting point of zinc. Zinc dust is often confused with zinc oxide, but they are very different products and the process will not work with zinc oxide (ZnO). The zinc powder used in the process is the zinc dust of commerce, and consists of very finely divided zinc coated with zinc oxide, (the metallic contents average about 85 per cent. and zinc oxide 15 per cent.). It is obtained during the process of distilling zinc from its ores. The specific gravity of zinc dust is 6·896. When tightly packed a cubic foot weighs 200 lb., and a ton of zinc dust occupies 11·2 cub. ft. When examined under the microscope it is seen to contain small bright metallic beads distributed through the dust. One of the peculiar properties of zinc dust is that it cannot be melted or reduced to the metallic form under ordinary conditions, even when heated to a very high temperature under considerable pressure. This property is very advantageous for Sherardising, as it does away with the risk there might otherwise be of melting the finely divided zinc by overheating the furnace.

As many erroneous and misleading statements have appeared in the Press from time to time, some particulars as to the inception and development may be of interest.

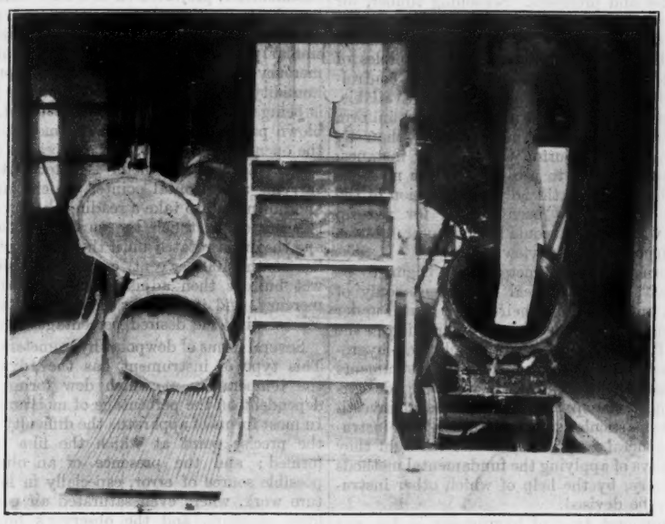


Fig. 1. Original Willesden Plant.

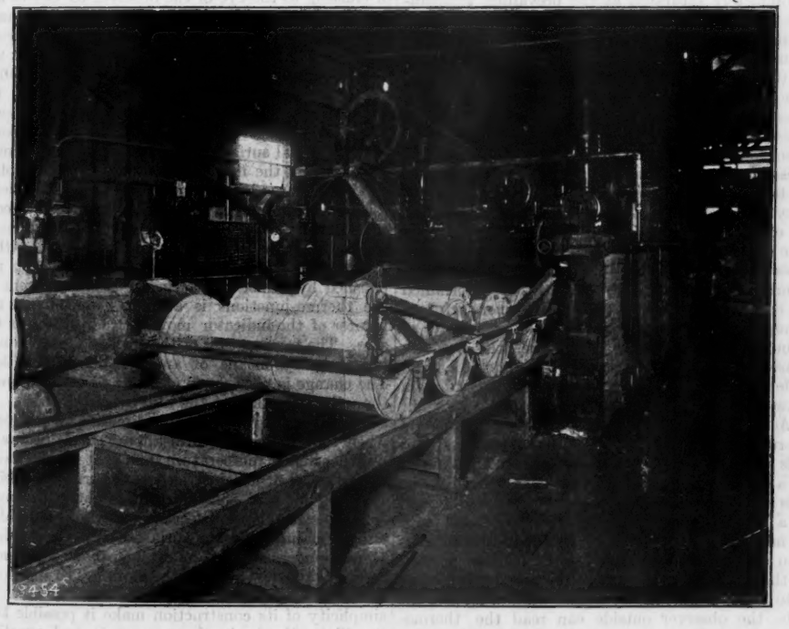


Fig. 3. Plant of the John Finn Metal Company.

The author was making some experiments in connection with the annealing of iron and tried heating cast iron in a closed receptacle filled with zinc dust, when it was observed that the iron became coated with a fine coating of metallic zinc, and subsequent examination showed the zinc had not only coated the iron but had alloyed with it and penetrated into the iron surface. This discovery led to a number of investigations being undertaken, and ultimately a small plant was erected in a workshop at Danvers-street, Chelsea. The apparatus used consisted of a wrought-iron cylinder with an opening at the side for inserting the zinc dust and articles to be Sherardised; the cover was made tight by driving in stepped wedges so as to force it against an asbestos packing. The drum was heated by a row of gas burners placed beneath it, and was rotated continuously or intermittently. This trial apparatus proved so successful that a small company was formed, who erected a commercial plant at Willesden. The plant comprised four furnaces capable of taking drums of 8 ft. × 2 ft. with a cubic capacity of about 2 tons of material at a charge, varying according to the shape and thickness of the articles to be Sherardised. The furnaces were heated by Dowson gas, led by iron pipes to the back of the furnace, and conducted through brick channels, through which the necessary air was drawn, the gas being burnt through large cast-iron rectangular burners placed beneath the revolving drums. The charging of the drums was effected by running the truck on which the drum was placed on to a table (Fig. 1) one end of which was lowered by means of gearing, so as to tilt the other end into which the zinc dust was charged from an upper floor by means of a shoot. The drum was discharged, after the Sherardising operation had been carried out, over an iron grating, allowing the zinc dust to fall into a chamber below from which it was raised by means of a chain elevator to the floor above. When the drum was charged with zinc dust and the articles to be Sherardised, it was brought into a horizontal position, the air exhausted, and the drum and under-carriage run along the rails until it arrived in front of the furnaces. The drum was then lifted on to a furnace under-carriage, the object being to effect a saving in the first cost of the undercarriages and to save waste of heat. The drum was then pushed into the furnace, the door lowered, and the furnace heated up to the desired temperature. The heat was regulated in accordance with the readings of a thermometer which was placed in a horizontal iron tube inside the drum, through one of the trunnions which was hollow. When the drum had been in the furnace a sufficient time to give the desired result the door was raised and the drum and under-carriage withdrawn, the drum lifted on to another under-carriage and run into an open yard where it was allowed to cool down to a temperature low enough to admit of easy handling of the contents.

Fig. 2. Steel Panel Inlaid with Zinc.

It soon became apparent that Sherardising could be applied to the inlaying and ornamenting of metallic surfaces, producing effects somewhat similar to those obtained by Damaskeening, the chief difference being that the metals are truly united; the designs are not only inlaid but can be raised and the metals blended together, forming a variety of alloys of many colours and tints, and it was found that when desired the inlaying could be made to penetrate through the surface to the back, and that the thickness and depth to which the metals could be inlaid or onlaid could be readily controlled by the operator. The process is capable of being applied to a large variety of metals, and has the advantage that many alloys can be formed in the one operation of baking. The *modus operandi* is as follows:—The article to be treated is coated with a "stopping off" composition—a thick paste of

whitening and linseed oil—those portions which are to be inlaid being left exposed. It is then placed in a box containing the zinc powder and baked at a temperature of about 600 deg. F., the depth of inlay depending on the length of time of the "bake," while the intermediate effects of the alloys and colourings are obtained by manipulation of the "stopping off" material. If the "stopping off" composition is made thin in parts the inlaying process will be retarded, and those portions where the "stopping off" material has been entirely removed will be inlaid: as an example, if copper is being inlaid with zinc, when the "stopping off" is thin the copper will be converted into brass, and where the "stopping off" is entirely removed the copper will be inlaid with zinc. The process is inexpensive and can be applied to the finest work, for instance, photographic work can be transferred. The process can be readily and effectively applied to the decoration of frames, table tops, panels, trays, vases, electric light fittings; in fact, to all classes of metal work. Some good specimens of this work can be seen at the South Kensington Museum. Fig. 2 is an illustration of blued steel panel inlaid with zinc.

The rights for America were sold, and a parent Company formed to control them. The policy adopted by this Company was exactly the reverse from that adopted by the English Company and proved very successful. The American Company granted licences to firms on a minimum royalty basis. The result was that Sherardizing soon became an industry of considerable magnitude; almost every large engineering firm taking a licence.

The articles which have been Sherardized are freed from all adherent zinc dust, by substituting a perforated lid for the solid one used when Sherardizing and subjecting the drum to a rumbling action in a closed chamber. A considerable economy in zinc dust is thus effected, and the time required for cooling reduced. A drum can be placed directly under this cooling and discharging apparatus so that the zinc dust can be discharged direct into it whilst warm and be immediately used again.

Fig. 3 illustrates an oil fuel plant erected in America by the John Finn Metal Company for Sherardizing. It consists of four drums, which are kept moving and at the same time slowly rotated by a reciprocating movement of the carriage. At the present time there are about one hundred plants in operation in the United States, and a large number on the Continent. The Germans during the War made most of their coinage out of iron which was Sherardized.

The original Sherardizing Patent, which was a controlling one, was taken out in 1901, and therefore has expired, so a number of firms are now using the process for their own special productions, and some firms undertake all classes of work for the trade. A few of the firms employ fancy distinctive names, such as "Thermozinc," "Galeco," "Zinc Alloy."

Calorising is a development of the Sherardizing process, utilising aluminium powder instead of zinc dust and baking at a much higher temperature. The process is found useful for coating ironwork which is subjected to high temperatures as the aluminium coating prevents the rapid oxidation and scaling of the iron or steel and increases its life several fold.

Journal of The Institute of Metals.—The first volume of the journal of this Institute for the current year (vol. xxxi) contains Sir Henry Fowler's lecture on "The Use of Non-Ferrous Metals in Engineering" and also deals with the proceedings at the last Spring Meeting. The papers that have given rise to the fullest discussion are those by Mr. W. E. W. Millington and Professor F. C. Thompson on "The Investigation of a Fatigue Failure of Brass Tubes in a Feed-Water Heater," and by Messrs. E. R. Jette, G. Phragmén and A. F. Westgren, on "X-ray Studies on the Copper-Aluminium Alloys." In both cases new views are advanced, and they receive a full measure of criticism. The papers are preceded by the address of the new President, Professor T. Turner, Birmingham University. The second portion of the book contains over 1,500 abstracts specially prepared from 500 periodicals—of which an easy reference list is given in a novel "key" form—dealing with all aspects of metallurgical work in every part of the world. The bibliography of the subject is given in an equally comprehensive manner, whilst the index is a very detailed one. The price of the volume is 31s. 6d. net.

SCIENCE AT THE BRITISH EMPIRE EXHIBITION.—VI.

In the Physics Section of the National Physical Laboratory, shown in the Palace of Engineering, hygrometry is illustrated with unusual fulness. Such an exhibit is valuable because to a large extent the subject has been neglected in this country, though it is of essential importance to a variety of industries and processes. Seasoning timber, for example, testing cottons, woollens and paper, curing tobacco, preserving foodstuffs and making photographic plates and films are all examples of processes that could profit by the means of controlling humidity, if they were more readily available, and in particular could turn out a more uniform product, sometimes much more rapidly than by ordinary methods. During the war, for instance, it was found possible to use hygrometric methods for seasoning timber artificially in a fraction of the time that would have been needed for natural seasoning, which indeed would have been prohibitive for the purposes then in view.

In modern times hygrometers have begun to be regarded as serious practical instruments only of late years, and even now their design is still under development. What, therefore, is interesting in the National Physical Laboratory exhibit of hygrometers is not only the precise form of instruments shown—most of them, indeed, represent designs made to meet the special requirements of investigations into particular problems rather than instruments for general purposes—but also the light they throw on ways of applying the fundamental methods of hygrometry, by the help of which other instruments may be devised.

The commonest type of hygrometer is the wet and dry bulb. This instrument, as will be remembered, is based on the fact that in an atmosphere incompletely saturated at the prevailing temperature a thermometer of which the bulb is covered with a film of moisture reads lower than a thermometer with a dry bulb to an extent determined by the heat withdrawn from the wet bulb by evaporation, which itself depends on the percentage of moisture in the air. As a fact, no satisfactory expression based on theoretical considerations has been found for the relation between the vapour pressure of aqueous vapour in air and the difference of temperature between dry and wet bulbs, but very satisfactory results have been obtained from an empirical equation involving these quantities. The humidity, however, is found to depend materially on the velocity of the air in the neighbourhood of the wet bulb when this is determined by convection currents. When, however, a forced draught is used so as to give the air a velocity of about 10 ft. per second or more, the velocity ceases to have any effect, and instruments having different sizes and shapes of bulb and sizes of stem give consistent readings.

Accordingly wet and dry bulb instruments should be run under a forced draught giving not less than this velocity, and one form of hygrometer, known as a tubular psychrometer, is shown (Fig. 58). In this instrument the thermometers are contained in a long steel tube, and are separated by a plate of mica running along their length to avoid radiation errors. The bulb end of the tube is inserted in the chamber of which the hygrometric condition is to be observed, and by a glass window let into the tube the observer outside can read the thermometers. At the further end of the tube a fan draws the air from the chamber at the necessary velocity. It is found that when the muslin round the wet bulb is moistened it will work satisfactorily for 40 minutes without attention. This arrangement requires thermometers of some considerable length, and an alternative is exhibited in which short thermometers can be used. In this the air of the chamber is circulated by a fan through a well-lagged tube, in one branch of which the bulbs of the thermometers are placed, separated as in the other instruments by a mica screen, the stems projecting through a sealed cover or bung. Here, again, the instrument is read by an observer outside the chamber.

In both these instruments the thermometer readings are translated into humidity by reference to tables, which is a somewhat clumsy procedure, and a form of hygrometer is shown in which the humidity is read direct from a chart prepared on the basis of the tables (Fig. 59). In this instrument the thermometers are mounted in front of a rotatable drum round which is wrapped a chart carrying curves, which represent percentage humidity at various temperatures. These curves are so drawn that if the surface of the mercury in the dry-bulb thermometer, projected on to a fixed-axial fiduciary line between the thermometers and parallel to them, lies on the 100 per cent. humidity curve, the similar projection of the surface of the wet-bulb mercury lies on the curve which represents the humidity to be measured. When the instrument is being used the wet bulb is moistened, and air is blown past the bulbs of the thermometers through the opening in its base, and escapes up the tubular body. Each thermometer is fitted with a sleeve carrying a horizontal pointer, which can be slid up and down, and to take a reading the dry-bulb slider is adjusted to touch the surface of the mercury and the drum rotated until the pointer of this slider lies on the 100 per cent. curve. The slider on the wet bulb is then adjusted to the surface of the mercury, and its pointer thus indicates the curve representing the desired percentage humidity.

Several forms of dewpoint hygrometers are shown. This type of instrument has the advantage that the temperature at which dew forms is directly dependent on the percentage of moisture in the air. In most forms of apparatus the difficulty is to detect the precise point at which the film of dew has formed; and the presence of an observer is a possible source of error, especially in low-temperature work, where even saturated air contains very little moisture, and the observer's breath might seriously upset the experiment. In one form of apparatus both these difficulties are avoided. Instead of trusting to the eye of the observer to detect the instant at which dew is precipitated, the change that is read is that which arises from the interference of the dew film with the radiation of heat from the hygrometer surface. The exhibit shown (Fig. 60) is an apparatus composed of the parts essential for this purpose. The heat from an electrical source—a gas-filled tungsten lamp—falls on to a polished concave metal surface, of which the temperature is regulated by the flow of brine under the control of a valve operated by a solenoid. This surface reflects the rays on to a concave metallic mirror, which concentrates them on to two tiny thermo-junctions in series, the leads from which are connected with a galvanometer indicator. When dew forms on the polished hygrometer surface, the steady current of the thermo-junctions is at once reduced and the pointer of the indicator moves rapidly towards the zero. The temperature of the surface is read simultaneously by means of another thermo-junction. The change is very much clearer and easier to read than the detection of the film by direct vision. A similar effect in the opposite direction is produced when the film begins to disappear; this occurs at a rather higher temperature than that at which dew begins to form, which strictly is the true dew-point. It is possible that the indicator might be arranged to serve as a relay for operating the solenoid valve, and so maintaining the surface always at the dew-point temperature, so as to obtain a continuous record of the dew-point in the room. The sharpness of the indication of this apparatus and the essential simplicity of its construction make it possible that it will be the basis of an accurate and practical hygrometer, in particular for low-temperature work. Other exhibits show a satisfactory method by which a silver surface is obtained for dew-point bulbs in which the reduction of temperature is obtained by bubbling air through ether. In order to ensure direct metallic contact between the ether container and the surface on which the film has to be formed the shaped and ground end of the tube through which the ether is introduced is successively platinised, copper-plated, nickel-plated, tinned, and then soldered to the silver thimble on which the dew is to be formed. Both the nickel and copper plating are found to be necessary to prevent the tinning from stripping the coating off the tube.

Examples are also shown of hair hygrometers,

together with a calibration chamber in which they can be compared. One form of hair hygrometer intended for distant reading was constructed by substituting for the clockwork drum in an ordinary recording hair hygrometer a stationary drum close-wound with oxidized wire (Fig. 61). The pointer has a silver contact piece instead of the pen, and the oxide insulation is rubbed off a longitudinal strip on the surface of the drum, so that the contact piece can make contact with the wire on the drum, and can thus be used to provide two arms of a Wheatstone's bridge. The other arms of the bridge are provided by a similar drum at the observation station. The resistance of the drum is 1,000 ohms. The height of the pointer is determined, as in the recorder, by the length of a hygrometer hair, and when it is desired to take a reading, the pointer is depressed by the operation of an electro-magnet so as to come in contact with the drum. The observer then balances the bridge in the usual way and thus determines electrically the position of the pointer on the drum, and consequently the extent to which the hair has elongated or contracted. It has been found practicable to avoid the effect of friction, which in such small forces as are here in question may be considerable, by introducing flexible strips in the connecting mechanism between the hair and the apparatus.

Another group of exhibits with direct practical interest is that referring to the measurement of heat and of the rate at which it is transmitted through various substances, shown mainly in the Palace of Engineering but partly in the Royal Society collection. This includes Sir Joseph Petavel's well-known arc furnace for work under pressure, and a form of optical pyrometer shown in operation. It also includes the apparatus by which as the result of investigations by Dr. Ezer Griffiths and Dr. G. W. C. Kaye (Proc. Roy. Soc. A., vol. civ, 1923, page 71), the thermal conductivity of various substances and the coefficients of heat transmission of typical walls were determined.* The most important features of the methods used for conductivity determinations will be understood by reference to Fig. 62 and Fig. 63. The sample is usually tested in the form of two rectangular slabs arranged on each side of hot plates with a resistor mat or heating coil between them, electrically insulated from the plates by thin sheets of micanite, the outer surfaces of the slabs lying as closely as possible against the cold plates (Fig. 62). The surfaces were made as flat as possible. The heating element is made of flat nichrome tape wound on a thin micanite sheet. The temperature of the cold surfaces is kept constant by the circulation of water through a tank kept at constant temperature by the heat of a large incandescent lamp controlled by a thermostat and relays (Fig. 63). The temperature rise of the water is measured by copper-constantan couples connected differentially in its inlets and outlets, and the temperatures of the hot and cold faces are measured by thermocouples soldered to copper discs and attached to the surface under test by a very thin layer of bitumen. The thermo-electric measurements are made on a low-resistance potentiometer reading to 0·1 deg. C., which is closer than the variations of temperature at different points of the same surface, arising from variations of composition in the material.

The flow of heat can thus be calculated accurately, and after equilibrium has set in, the required coefficients can be calculated. Where the conductivity is relatively high, as in walls, only a single slab is used, and the four edges and back of the slab and its hot and cold plates are surrounded by thick layers of material of much lower conductivity (slab or granulated cork). In this arrangement the relatively small flow of heat through the edges of the slab—about 6 per cent. of the total dissipated in the resistance—is calculated accurately enough; but where the material under test has itself a lower conductivity it is found preferable to measure this independently. This is done, as is shown in the exhibit, by using a "guard ring," a four-sided ring arranged round the slab under test and of similar construction to the main apparatus in which the block is contained. This ring is maintained constantly at the same temperature as the slab, and thus prevents edgewise flow of heat, and ensures that all the heat passing through the slab flows normally to its surface.

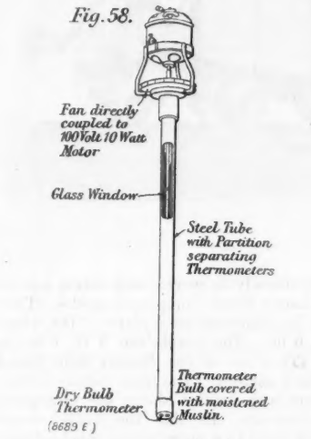
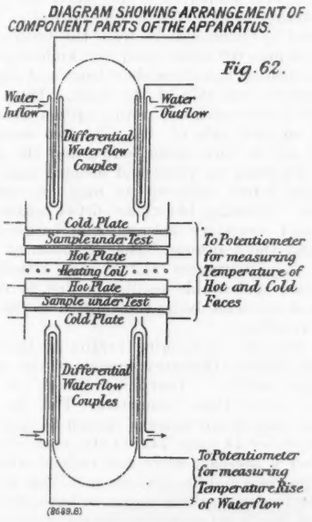


Fig. 58.
Fan directly coupled to 100 Volt 10 Watt Motor
Glass Window
Steel Tube with Partition separating Thermometers
Thermometer Bulb covered with moistened Muslin.
Dry Bulb Thermometer
(8689 E)



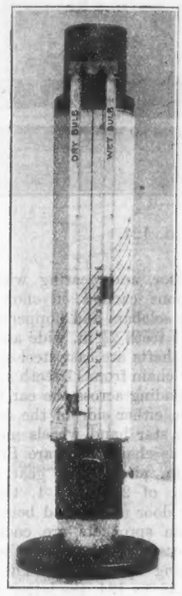
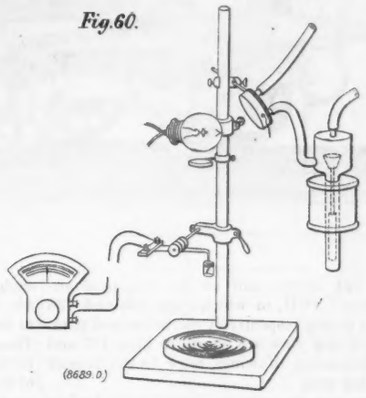
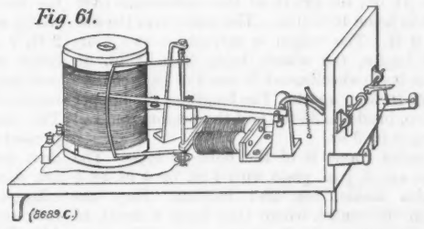
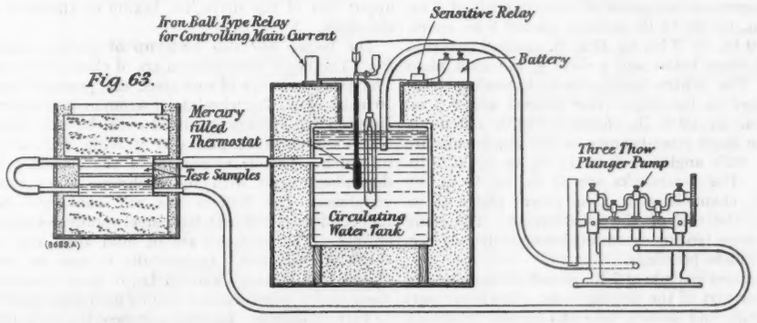


FIG. 59.







BRITISH EMPIRE EXHIBITION: RAILWAY MATERIAL.—VI.

THE only large exhibit of its class of steel railway wagons is to be seen at the stand of Messrs. Cammell Laird and Co., Limited, in the form of a 42-ton hopper wagon for coal traffic on the Bengal and Nagpur Railway, India (5 ft. 6 in. gauge). This wagon is one of an order executed by the Midland Railway Carriage and Wagon Company, Limited, Birmingham. It is similar in general lines to one illustrated in ENGINEERING in 1922,* but several modifications have been introduced in the present instance. The wagon is illustrated in the general

* See ENGINEERING, September 14, 1923, page 338.

* See vol. cxiii, page 292.

42-TON HOPPER WAGON AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY THE MIDLAND RAILWAY CARRIAGE AND WAGON COMPANY, LIMITED, BIRMINGHAM.

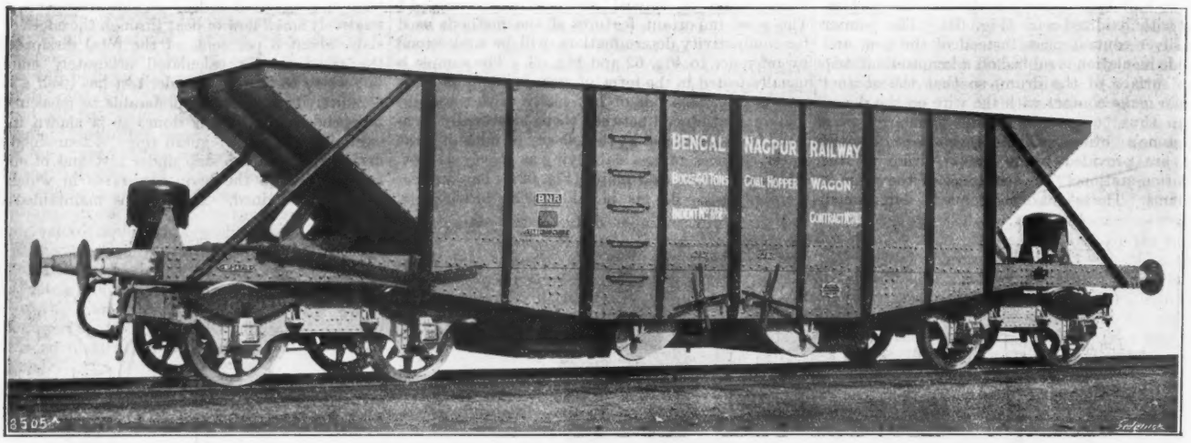


Fig. 124.

view, Fig. 124 above, and on the two-page engraving, Plate XXVII, in which Figs. 125 and 126 are drawings giving respectively elevation and plan. A section and end view are shown in Figs. 127 and 128. The remaining drawings refer to the hopper door-operating gear.

The wagon has an extreme length over buffers of 44 ft. 11 in., the length of the underframe over headstocks being 40 ft. 9 in. The width over the sole bars is 9 ft. The wagon is carried on two four-wheeled bogies, the wheels being 3 ft. 1 in. on tread, the bogie wheelbases 6 ft. and the bogie centres spaced 29 ft. 3 in. apart. The length of the hopper at the top, inside, is 35 ft., and the height from rail to coping 9 ft. 9 in.

The under frame is of the built-up type. The sole bars are of $\frac{1}{2}$ in. plate with 4 in. by 4 in. by $\frac{5}{8}$ in. angles inside, top and bottom. They are bellied in the centre, where they have a depth of 2 ft., diminishing to 10 in. at the ends. The bogie cross bearers are composed of two channels of 4 in. by 10 in. by 30·16 lb. section, spaced 9 in. apart, with a 9 in. by 3 in. by 19·3 lb. channel inverted between them below and a wide $\frac{5}{16}$-in. cover plate above. The centre longitudinals extending from the hopper to the bogie cross bearers are of 3 in. by 10 in. by 19·8 lb. channels, while extending from the bogie cross-bearers to the headstocks are splayed bulb angles of 9 in. by $3\frac{1}{2}$ in. by 22·7 lb. section. The headstocks are $3\frac{1}{2}$ in. by 10 in. by 23·55 lb. channels, with $\frac{5}{16}$-in. gusset plates 15 in. wide on the top of the underframe. The main hopper cross-bearers extending between the sole bars are $\frac{3}{8}$-in. plate pressings.

The hopper is made of 7-lb. plate for the sides and the upper part of the sloping ends. The lower part of the ends and sloping side and middle floors are of 10-lb. plate. The sides overlap, and are riveted direct to the solebars, being supported alternately by a channel and tee stanchions, spaced 3 ft. apart, the former of a section of 5 in. by $2\frac{1}{2}$ in. by $\frac{5}{16}$ in. and the latter 4 in. by $2\frac{1}{2}$ in. by $\frac{3}{8}$ in. The hopper ends are supported from the centre longitudinals by $\frac{5}{16}$-in. pressings, while diagonal 4 in. by $3\frac{1}{2}$ in. by $\frac{3}{8}$ in. tees extend from the end hopper side panels to the ends of the solebars At the sides the sloping hopper floors are supported from the solebars by $\frac{5}{16}$-in. pressings, as may be seen in Fig. 127.

The two hopper doors each give an opening 3 ft. 6 in. by 3 ft. 6 in., the doors being inverted trays of 12 lb. plate with 3-in. flanges and V-shaped stiffeners of pressed $\frac{1}{4}$-in. plate. They are fitted with rollers and work on horizontal rails of $5\frac{1}{2}$ in. by $3\frac{1}{2}$ in. by $\frac{1}{2}$ in. angles. The door arrangements are best seen in Figs. 129 to 131, particularly in the cross section, Fig. 130. The doors are operated by racks and chain-driven pinions. One rack is fitted each side of each door, and gearing with these are tough steel pinions carried on short shafts in bearings under the solebars and hopper bottom. These pinions have 11 teeth $2\frac{1}{2}$ in. wide and $1\frac{1}{2}$ in. pitch. On the same shafts are cast steel sprockets of 40 teeth, driven by chain from 11 teeth sprockets on a $1\frac{3}{4}$ in. shaft extending across the car between the two solebars. On either side of the car these shafts are fitted with star hand wheels measuring 2 ft. 7 in. across. The chains used are Brampton roller chains of $1\frac{1}{4}$ in. pitch. The gear gives a mechanical advantage of 21·46 to 1, the effort required to move the door under load being 70 lb. The chains and chain sprockets are enclosed in pressed steel oil-bath cases, which protect them from dust during discharging operations. These cases are shown in Figs. 132 to 134, the latter being to a larger scale than the two former. Details of the rack are given in Figs. 135 and 136. Figs. 137 to 140 illustrate the adjusting arrangement at the upper end of the drive, for taking up the slack in the chain.

The bogies are also built up of plates, angles, &c. The bogie cross bearers are of channel section. The axle boxes are of cast steel, the journals being 10 in. by $5\frac{1}{2}$ in. The wheels have wrought-iron centres. Independent springs are fitted over the axle boxes. These consist of 12 plates $3\frac{1}{2}$ in. wide, $\frac{5}{8}$ in. and $\frac{1}{2}$ in. thick. The draw gear is of the standard independent type with nickel-chrome steel screw couplings. The buffers are self contained and independent, fitted with both steel volute and rubber springs. The plungers are of mild steel and the shells of cast steel. Incidentally it may be mentioned that Messrs. Cammell Laird show a series of these buffer cases crushed cold by hydraulic pressure to varying degrees. In some instances the shells have crumpled so completely under this test as to entirely close the shank hole, yet without the least sign of a crack showing up on the casting. The wagon is fitted with two vacuum brake 18 in. cylinders carried over the ends of the underframe, one cylinder working the brakes on each bogie, and being in both instances combined with hand levers.

The tare weight is 21 ton 17 cwt., and the load 42 tons, reckoning 42 cub. ft. of coal to the ton. The wagon was subjected to a test load giving 80 tons on the rails, under which it showed up very satisfactorily.

Another exhibit at the stand of Messrs. Cammell Laird and Co. is a double bolster bogie built by the Leeds Forge Company, Limited, now associated with Messrs. Cammell Laird. This bogie is illustrated in Figs. 141 to 146, page 281. It is of the type used for its long coaching stock by the London and North Eastern Railway, and gives exceedingly smooth riding. A number of the type are already in service and others are in hand at the Leeds Forge Company's works. The bogie is built up of pressed steel plates. The wheel base is 8 ft. 6 in. The wheels are 3 ft. 7 in. in diameter. They are of the Newlay solid forged and rolled steel pattern. The main feature of the bogie is, as has been implied above, the arrangement of double bolsters. In this the bogie centre cup casting is fixed to a main bolster much of the usual type (Fig. 143), supported on four sets of coil springs by its spring plank. The latter, instead of being suspended by inclined links from the transoms, is carried on inverted yokes fitted with knife edges and hung by inclined links from short lengths of channel, one towards each side of the bogie. These span the main bolster each end resting upon a secondary bolster on each side of it. The two secondary bolsters are in turn spring-borne, and the spring planks are slung by yokes and inclined links from the bogie frame transoms as may be seen in Fig. 144. Rubbing blocks are fitted between the main and secondary bolsters and between the latter and the transoms. The arrangement gives a very easy movement and is very effective in preventing undesirable oscillation due to irregularities of the track being transmitted to the body of the vehicle.

The principal engineering exhibit of the Great Western Railway Company consists of the express passenger engine "Caerphilly Castle," a four-cylinder 4–6–0 type locomotive. This we illustrated so fully in our issues of August 24 (page 236) and December 14 (page 742) of last year, when we published a two-page plate and various other sectional drawings and illustrations of it, that we must refer our readers to the accounts we have previously given for details of this engine. We may just mention that the engine has four cylinders 16 in. in diameter by 26-in. stroke, driving wheels 6 ft. $8\frac{1}{2}$ in. in diameter, and a working pressure of 225 lb. per square inch. The adhesive weight is 58 tons 17 cwt. The engine is a very fine example of modern practice on a system which has adopted a line of design which in many respects is unique among the British companies, with, we may add, very conspicuous success.

Of the three locomotive building firms exhibiting heavy locomotives at Wembley two are builders who have entered this field since the war. We have already dealt with the locomotive exhibit of Messrs. Wm. Beardmore, Limited. We now propose to deal with that of Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, who, as is well known, converted very expeditiously their Scotswood works to locomotive building on the cessation of the need for war material. This firm is showing at Wembley a heavy 4–8–0 type superheater locomotive, built

DOUBLE BOLSTER RAILWAY CARRIAGE BOGIE; BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY THE LEEDS FORGE COMPANY, LIMITED, ENGINEERS, LEEDS.

Fig. 141.

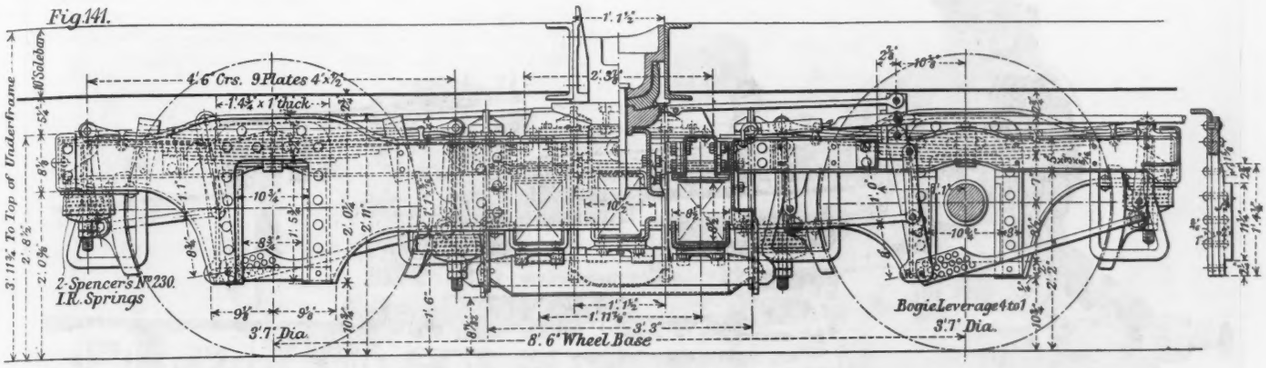


Fig. 142.

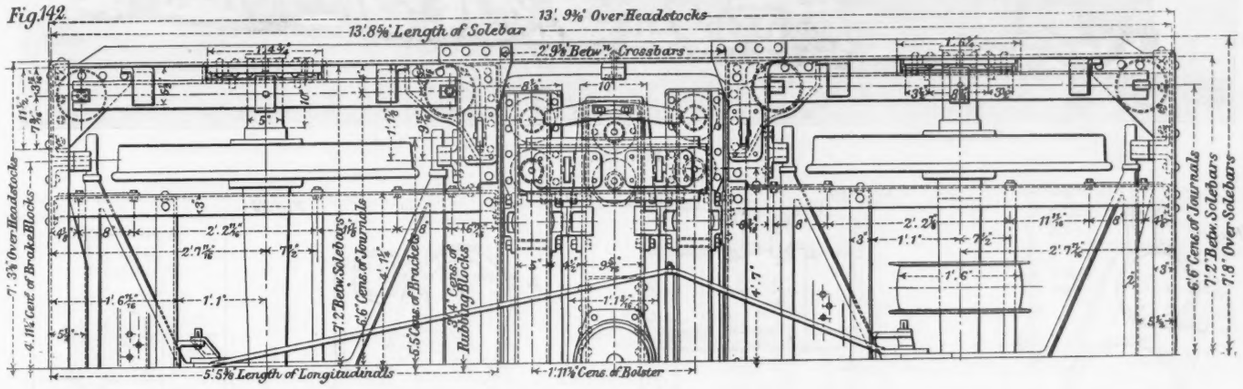


Fig. 143.

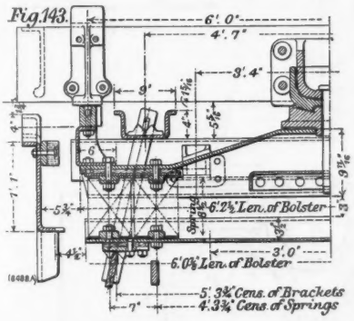


Fig. 144.

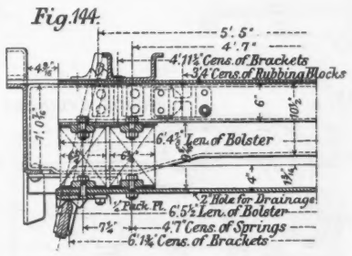
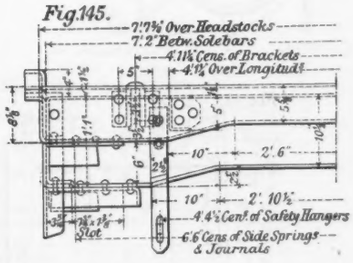


Fig. 145.



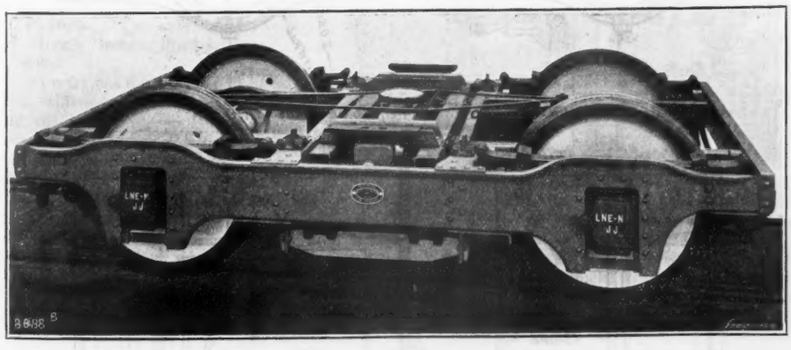


FIG. 146.

for the Buenos Ayres Great Southern Railway Company, Messrs. Livesey, Son and Henderson acting as the Company's consulting engineers. The engine shown is one of an order for 25 simple superheater locomotives with three cylinders. It is illustrated in the general view, Fig. 147, while details of the cylinders are given in Figs. 148 to 156, page 282, and drawings of the valve gears are shown in Figs. 157 to 161 on page 283.

The engine is constructed for the 5 ft. 6 in. gauge. The three cylinders are 17½ in. in diam. by 26 in. stroke. The driving wheels are 4 ft. 7½ in. in diam., and the working pressure is 200 lb. per square inch. Other dimensions, &c., are given in the table on page 284. The outside cylinders are illustrated in Figs. 148 to 151. They are fitted with piston valves 10 in. in diameter. The centre line of both piston rod and valve rod are on an incline of 1 in 15, and the castings are made plain, with front and back covers bolted on. The outside cylinders are bolted to plate frames 1⅛ in. thick, the inside cylinder being arranged slightly to the rear between the frames. All three cylinders drive on to one axle (the second coupled), which is, therefore, cranked. The inside cylinder is inclined at 1 in 6½, so that the gear may clear the leading coupled axle. The inside cylinder casting is illustrated in Figs. 152 to 156, from which it will be seen that the piston valve is arranged to one side of the centre, this plan being adopted to keep the height of the casting as small as possible. Independent steam pipes from the superheater header in the smoke-box supply the three cylinders, the two pipes for the outside cylinders passing through the smoke-box sides, as in American practice. The exhaust pipes from the outside cylinders are carried into the smoke-box over the frames, while that for the inside cylinder is branched forward from the casting by way of the rectangular opening shown in

4-8-0 TYPE THREE-CYLINDER LOCOMOTIVE; BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, NEWCASTLE-ON-TYNE.

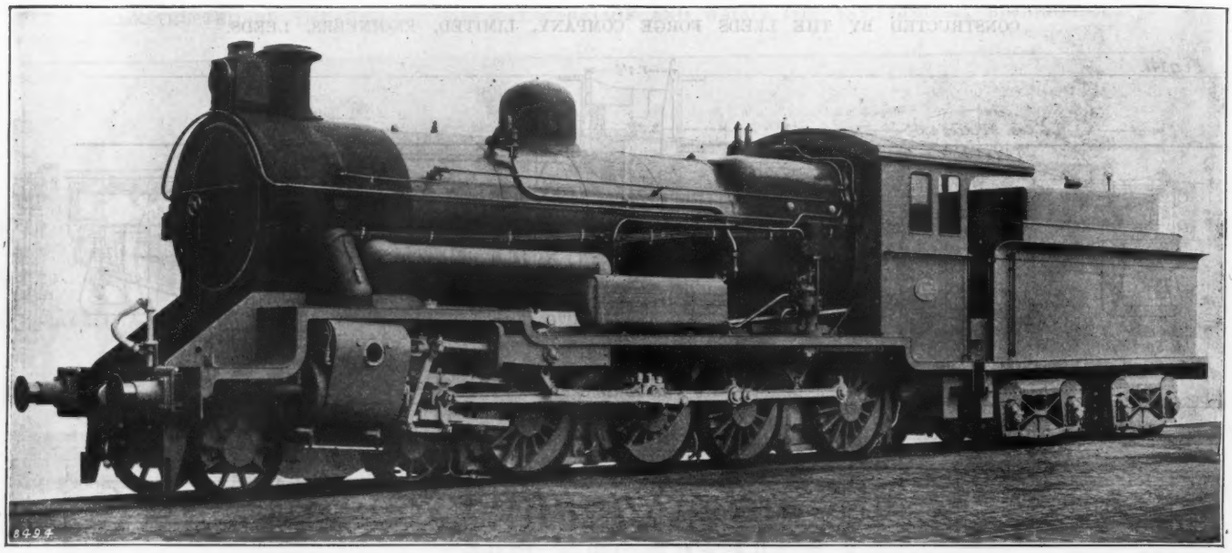
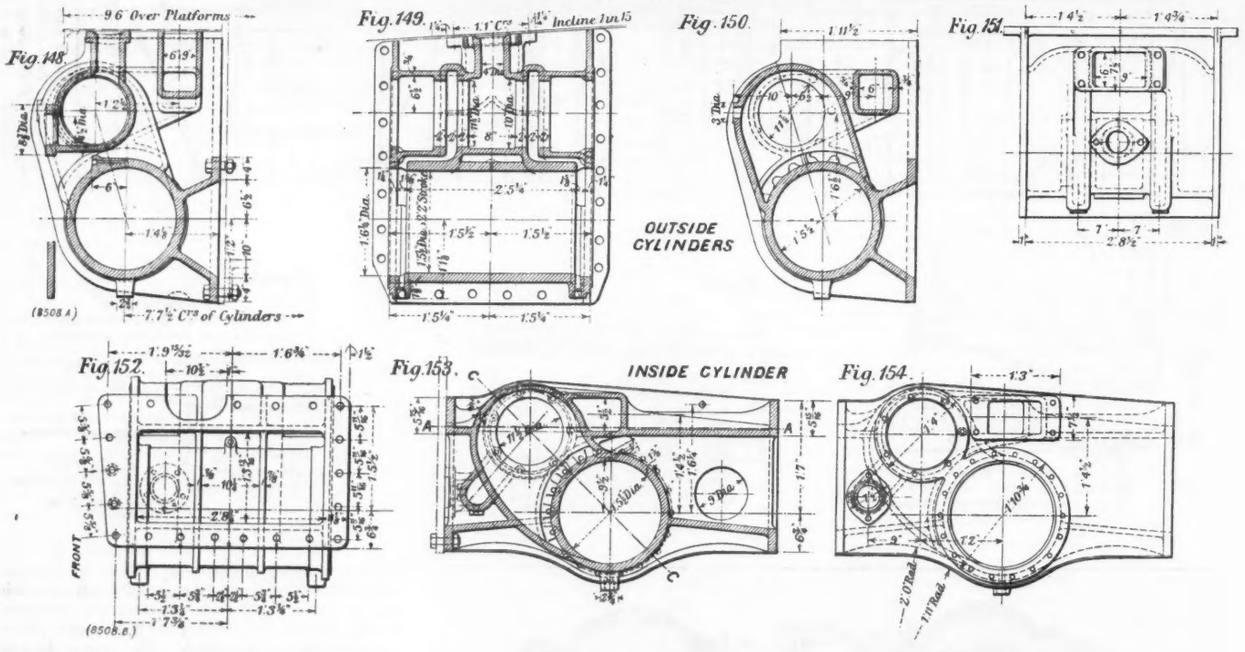
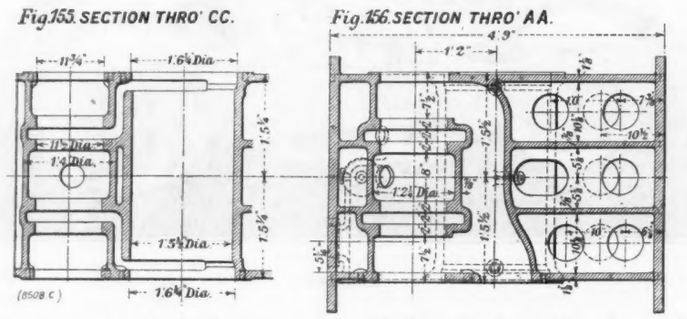


FIG. 147.



Figs. 154 and 156. The three join inside the smoke-box, combining into a single blast pipe. The crossheads of the outside sets are of the alligator type with top and lower bars. The inside crosshead is of the single bar type. The valve motion for all three cylinders is, in each case, of the independent Walschaert type, the outside cylinder sets being of normal design, with a small return crank outside the main crank-pin. The inside set derives its motion from the inside crosshead and from an eccentric placed to one side of the inside crank. These features will be clear from Figs. 157 and 158 on page 283 which show the outside gear, and Figs. 159 to 161, which illustrate the inside gear. The three sets are controlled by one screw-reversing gear.



The driving wheels are 4 ft. 7½ in. on the tread and those of the bogie 3 ft. 2 in. in diameter. The leading coupled wheels are fitted with flangeless tyres 6½ in. wide, and the intermediate coupled wheels with flangeless tyres 6 in. wide. The main driving and the trailing tyres are flanged and 5½ in. wide. The main crank axle is 9 in. in diameter, with journals 9 in. in diameter by 10 in. wide. The coupled axles are 7½ in. in diameter with journals 8 in. in diameter by 9 in., the bogie axles being

4-8-0 TYPE THREE-CYLINDER LOCOMOTIVE; BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, NEWCASTLE-ON-TYNE.

Fig. 157.

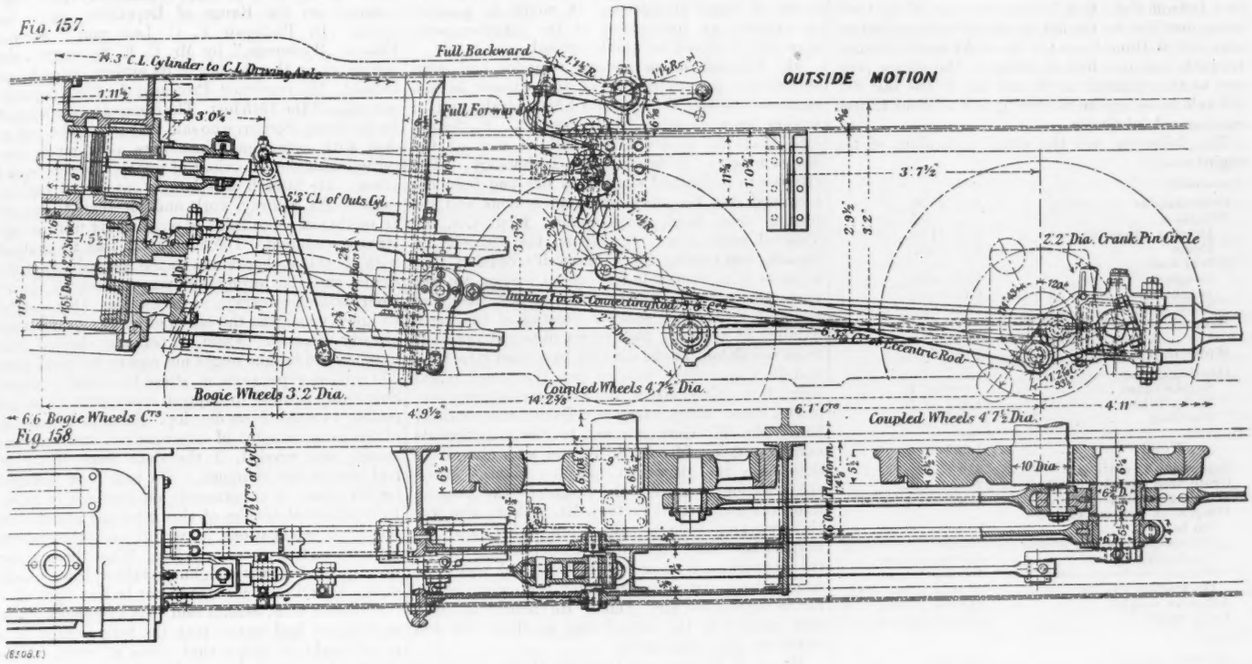


Fig. 158.

Fig. 159.

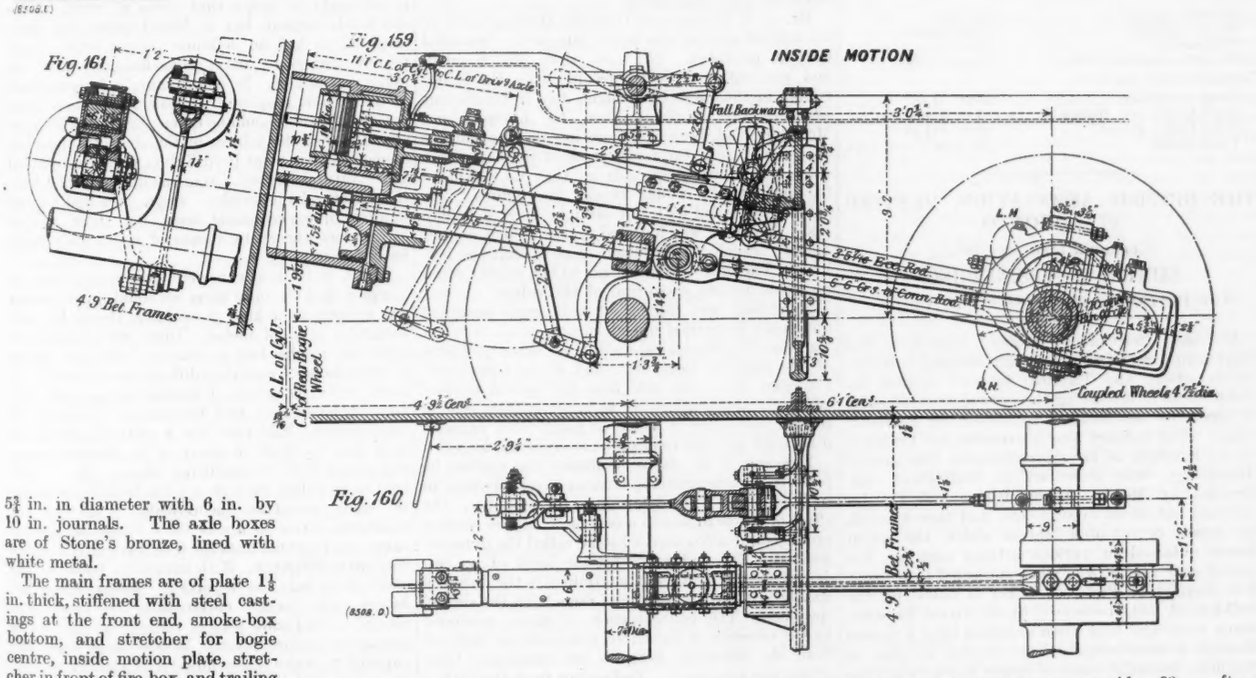


Fig. 161.

Fig. 160.

5⅞ in. in diameter with 6 in. by 10 in. journals. The axle boxes are of Stone's bronze, lined with white metal.

The main frames are of plate 1⅛ in. thick, stiffened with steel castings at the front end, smoke-box bottom, and stretcher for bogie centre, inside motion plate, stretcher in front of fire-box, and trailing drag-box. Yokes are also fitted outside the frames for the outside slide-bars. The horn blocks are of cast steel, the horn stays being of the through bolt type. The springing of the bogie is independent for each axle box. That for the coupled wheels is equalised.

The boiler has a barrel diameter of 5 ft. 5¼ in. outside at the front (smallest) ring, increasing to 5 ft. 8 in. outside at the third ring. The barrel plating is ⅜ in. thick. The length of the barrel is 16 ft. The barrel contains 24 steel superheater tubes 5½ in. in outside diameter, and 130 steel tubes 2⅛ in. in diameter. The tubes are fitted with copper ferrules ⅛ in. thick, rolled into the tube plate and not brazed to the tubes. The tubes after expanding and beading over are electrically welded to the fire-box tube plate. The whole of the fire-box is of steel, all fire-box stays being of hollow stay bolt iron. The fire-box plating is ½ in. thick and the sides and back of the shell ⅝ in. thick. The throat plate is ⅜ in. thick. The length inside the fire-box is 7 ft. 3⅝ in. and the width 3 ft. 11¾ in. The water spaces are 3 in. wide at the foundation ring. The superheater consists of 24 elements of the Marine and Locomotive Superheaters, Limited, pattern. The boiler is furnished with a Hulburd Servo regulator, and with two muffled Ross pop valves set for 200 lb. per square inch. Damper gear is not fitted to the superheater. One Sellers injector is provided and also a Weir feed pump and feed heater. The pump has a steam cylinder diameter of 7⅞ in., pump cylinder of 5½ in. and stroke of 9 in. The feed heater provides 60 sq. ft. of heating surface and is connected with the combining limb of the blast pipe. The fire-box is arranged for oil-fuel burning, "Best" type burners being used and the lower part of the box lined with brick.

The tender is of the double-bogie type, having a water tank capacity of 4,000 gallons and oil fuel capacity of 8¾ tons, or coal capacity, with oil tank removed, of 7 tons. The oil-fuel tank is rectangular, 13 ft. 3¼ in. long inside by 8 ft. wide outside and 3 ft. 6⅛ in. high. The water tank is 19 ft. 5½ in. long outside and 8 ft. 9 in. wide. The oil tank bottom slopes slightly forward. The two bogies have wheel bases of 5 ft. 6 in. and are centred 10 ft. 3 in. apart.

The engine is fitted with a steam brake, operated

in conjunction with the vacuum brake on the tender, the ejector for which is of the Westinghouse pattern. The engine cylinders are lubricated by means of two Detroit sight feed lubricators, one of six feeds being provided for the left-hand and inside cylinders, and one of three feeds for the right-hand cylinder. In each case one feed is taken to the steam pipe, one to the cylinder barrel and one to the tail rod. All axle boxes are lubricated by a Wakefield 12-feed mechanical lubricator.

The following are the chief particulars of the engine :—

Locomotive—	
Cylinders (3)	17½ × 26.
Wheels—	
Driving, diameter	4 ft. 7½ in.
Bogie ,, ...	3 ft. 2 in.
Wheel base—	
Coupled	17 ft. 6 in.
Bogie	6 ft. 6 in.
Total engine	28 ft. 9½ in.
Height from rail to top of chimney	14 ft. 8 in.
Width over cylinders	10 ft. 5½ in.
Heating surface—	
Smoke tubes	540 sq. ft.
Boiler tubes	1,192 sq. ft.
Fire box	155 sq. ft.
Total	1,887 sq. ft.
Superheating surface	410 sq. ft.
Grate area (coal-burning) ...	29·3 sq. ft.
Working pressure	200 lb. per sq. in.
Weights in working order—	
On bogie	19 tons 16 cwt.
On leading coupled wheels ...	15 tons 17 cwt. 3 qr.
On driving wheels ...	15 tons 16 cwt.
On intermediate wheels ...	15 tons 19 cwt.
On trailing wheels	16 tons 5 cwt. 2 qr.
Adhesive weight	63 tons 17 cwt. 5 qr.
Total weight	83 tons 14 cwt. 1 qr.
Tender—	
Oil fuel capacity	8¾ tons.
Water capacity	4,000 gallons.
Wheelbase	15 ft. 9 in.
Weight in working order ...	51 tons 7 cwt.
Locomotive and Tender—	
Total wheel base	55 ft. 1½ in.
Total length over buffers ...	64 ft. 5 in.
Total length overall	66 ft. 11½ in.
Total weight	135 tons 1 cwt. 1 qr.

THE BRITISH ASSOCIATION MEETING AT TORONTO.

(*Continued from page* 267.)

SECTION G.—ENGINEERING.

The Determination of Stress by Optical Methods.

On the afternoon of Friday, August 8, the Engineering Section held a joint meeting with the Mathematical and Physical Science Section for the purpose of discussing the optical determination of stress by the method advocated by Professor Coker. The subject was introduced by Professor A. L. Kimball, of the Massachusetts Institute of Technology, who described an instrument constructed by Messrs. Adam, Hilger and Co. for carrying out stress experiments, and then showed, by means of coloured lantern slides, the colour bands obtained in various articles such as test pieces, gear wheels, &c., when subjected to stresses. The method of Professor Coker is based on the well-known fact, discovered by Sir David Brewster many years ago, that when polarised light is passed through a transparent substance such as glass or celluloid, beautiful bands of colour appear when the substance is stressed. The configuration of these bands is related to the direction and intensity of the stress on the material, and attempts have therefore been made to turn the phenomenon to practical account in engineering investigations. The trend of the discussion appeared to show that, beautiful as the method appeared, its application to practical problems was very limited. It was pointed out by the first speaker, Mr. Preston, that the photo-elastic method, as it is called, shows only the difference of the principal stresses at any point of an object. To determine the principal stresses their sum must also be known, and to get this Professor Coker had had to rely on measurements of changes of thickness made by an extensometer. The method was not therefore a simple optical one, but was partly mechanical and very tedious. The use of an extensometer was indeed a backward step because the magnitude of the change to be measured was, on account of Poisson's ratio, only about one quarter of that due to a direct stress of equal magnitude. It might be possible to produce an instrument of the interferometer type which should be wholly optical.

Mr. Kimball, in his opening remarks, had mentioned the determinations of the stresses in the structure of the U.S. airship Shenandrah, and in answer to a question by Professor C. F. Jenkin said that the model used could be seen at the Massachusetts Institute of Technology. The stresses in individual struts and ties had been determined, but the work was very tedious and the results were kept very secret. Lieut.-Col. de Villamil made some remarks on the viscosity of liquids, mentioning Clerk Maxwell's opinion that a stress in a viscous liquid caused motion to take place by repeated minute steps, rather than continuously. Another speaker questioned the justifiability of applying the results obtained optically from a celluloid model directly to a steel structure, and it was further pointed out that steel might suffer from initial stress due to manufacturing processes, from which stresses celluloid was entirely free. Mr. W. Gore referred to the experiments carried out by Mr. J. S. Wilson and himself to determine the stress on masonry dams. When the question of raising the height of the Assouan dam was under consideration, Mr. Wilson, who was then working with Sir Benjamin Baker, and the speaker had made indiarubber models and by noting the distortion of these under stress had been able to determine with close accuracy the nature of the forces acting at any point. He much preferred this method to the optical one, as there was less inference about the results.

Mr. J. S. Wilson said that the attractiveness of the optical method was largely due to the beautiful colours produced. The fact that Mr. Kimball had not obtained better results with the india-rubber method was he thought due to insufficient attention to details. When he himself, and Mr. Gore had been collaborating on the subject they had placed their rubber sheet on a piece of glass resting on steel balls so that no unknown frictional forces would vitiate the figures. The rubber was ruled with fine straight lines in Indian ink. A camera was focussed on the rubber surface and a graticule was adjusted so as to split the ink-lines. The effect of any stress to the rubber could be noted by the distortion of the rubber surface. The method was capable of very great accuracy and could be carried out at leisure, which was not the case with the optical method in which questions of the effect of heat, &c., had to be considered. Professor F. C. Lea said that the optical method could give information as to static stresses due to certain forces, but it would be much more valuable if it could give information as to dynamic forces.

Professor T. M. Jasper indicated the method he preferred for determining stresses experimentally in certain cases. To determine, for instance, the effect of a hole drilled in a test piece, on the stresses produced, he advocated what he called the dynamic method. The endurance fatigue limit of an undrilled specimen was first determined in the ordinary way, and then the same was done with the drilled specimen. The concentration of stress produced by the presence of the drilled hole could be deduced from the difference between the endurance limit of the two specimens. Deductions from the optical method would indicate that the presence of a small hole increased the stress three-fold, whereas the dynamic method showed that it was not increased by more than half this amount. These remarks applied to ordinary ductile material, but for hard and brittle material the discrepancy between the optical and the experimental method was not so great. Professor Jasper believed that we were on the eve of a method of determining stresses which would not depend at all upon optical principles.

The Fatigue of Metals.

The Engineering Section reassembled on Monday, August 11, to consider the following papers, dealing with the question of the fatigue of metals, namely, "The Evidence for the Existence of an Endurance Limit in Metals," by Professors H. F. Moore and T. M. Jasper, "The Work of the Fatigue Panel of the Aeronautical Research Committee," by Professor C. F. Jenkin; "The Effect of High Temperature on the Range of Repetition Stress for Steels," by Professor F. C. Lea, and "Torsion Fatigue Hysteresis," by Mr. C. E. Stromeyer, the last paper, in the absence of its author, being taken as read. We reprinted Professor Jenkin's paper in our issue of the 15th inst. The discussion was opened by Sir Henry Fowler, who said that those who had to deal with actual machines were very much concerned with the behaviour of metals under repeated stress. He himself was largely interested both in vehicles for railway work and for road transport. In neither of these fields of engineering were steady stresses common. The motor car had to contend with continual shocks due to the inequalities of the roads, and the locomotive was subject to shocks from striking crossings, switches, &c. One wanted to know what was the effect of shocks on material already stressed. Again, experience showed that flaws due to fatigue might not commence until after 250 million repetitions of stress in actual practice. Something seemed to happen, even after so long a period, to make flaws develop. Some co-ordination of the large amount of experimental and practical results was needed, if the data were to be of real use to the designer. He had been engaged for 20 years in experiments on locomotive axles. In commercial articles of this kind one always had the risk of segregations, impurities and other defects from which test-pieces were free. What the engineer usually needed was toughness rather than tensile strength, and this fact should not be lost sight of.

Professor C. F. Jenkin said that Professors Moore and Jasper had stated that the fatigue limit of a metal might be below that stress at which visible slip-bands formed, but as Monel metal and some other alloys had no defininte fatigue limit, it appeared that some other consideration must be taken account of. In determining a fatigue limit, in the speaker's opinion, at least ten million alternations of stress should be taken. Sir James Henderson said that the subject of the strength of metals seemed to be in what Lord Kelvin would have called the "Natural History" stage as distinguished from the "Natural Philosophy" stage. We had a great number of experimental facts, but there was no satisfactory theory by means of which they could be correlated.

Mr. J. S. Wilson considered the matter was so complex that the only thing we could do at present was to form some kind of workable theory for each particular kind of metal. Those who would correlate all results had to contend with the effects of differences of material, differences of heat treatment, different speeds of fatigue testing, &c., and now Professor Lea had introduced differences of temperature. Mild steel was a material which was in a class by itself in many of its characteristics, and might well be considered alone. If a small hole were drilled through a plain fatigue specimen, the result would be, theoretically to increase the maximum stress to about three times its former value, yet in actual tests the hole was found to make very little difference. With hard steel, however, the effect of the hole was important. Messrs. Moore and Jasper were hardly encouraging to those who wanted to find some way of testing the capacity of metals to endure fatigue in less time than was required to make many millions of stress reversals. He agreed with Sir Henry Fowler that some quicker method was wanted.

General C. H. Mitchell considered that the attention paid to the fatigue of metals was the great feature of the current meeting of the British Association. Professor Lea had been making experiments on the strength of metal at high temperature, but they in Canada had often to operate machinery at temperatures as low as 50 deg. below zero Fahr. It was possible that some of the accidents which had taken place were due to failure of metal under shock at low temperature. Workmen regarded metal as more brittle at low temperatures and it would be well to know the exact effect of practical degrees of cold on strength. Professsor Hudson Beare referred to tests of Monel metal which he had made and which had been published in Engineering. He had tested specimens up to 17 million reversals of stress and recollected that there was a definite endurance

limit. It was interesting to inquire what was the effect of the rapidity of reversal of stress. In ordinary practical work metal was rarely subjected to extremely rapid reversals of stress, and the results obtained at different rates of reversal had apparently never been correlated. Professor Ellis referred to the existence of two theories as to metallic structure, one that the crystals were in contact, and the other that they were separated by an amorphous layer. Experiments on thin oil films on water, carried out at the Toronto University had caused the speaker to formulate a new theory of inter-crystalline structure. The oil-film on water was seen under the microscope to break up ultimately into thousands of tiny little spheres. It seemed possible that the amorphous layer in metal also broke up into small spheres, and left definite vacuous spaces between them. The inter-crystalline stress had to be taken up by the layer of spheres.

Referring to General Mitchell's remarks on the strength of metal in cold weather, Mr. J. S. Wilson said that he had recently been told by a foreman that many more rivets could be cut out by a squad of men on a cold day than on a warm one. Professor Moore, referring to the remarks which had been made in one of the papers as to the effect of minute scratches, said that it must not be taken that deep scratches were harmless. He mentioned a testing machine which comprised an adjusting screw, the cross-section of the screw being four times that of the specimen to be tested. The thread was United States standard, and, in spite of the comparatively large area of the screw, it always broke sooner or later. The Whitworth form of thread appeared to be superior to the United States standard, but the trouble was eventually stopped by eliminating the screw altogether.

Professor A. L. Kimball stated that he had found a definite dissipation of energy in alternating stress tests considerably below the elastic limit of the material. This pointed to a viscous characteristic of the material. Indeed, were there not some dissipation of energy a body set vibrating in a vacuum would continue to vibrate indefinitely, which was certainly not the case. Professor F. C. Lea expressed doubt as to whether we should ever get a true philosophical explanation of the behaviour of metals under stress. A complete theory was never arrived at all at once, it came by steps. He had started long-period fatigue tests in 1917 on an aluminium alloy, which had stood 250 million reversals of a low stress without fracture. With logarithmic plotting there did seem to be a continuous falling of the S–N line for some materials after the point of inflection, but for ordinary carbon steels there appeared to be definite evidence of a fatigue limit, *i.e.*, a limiting stress below which fracture did not take place. The real difficulty in applying test results to practice was that in everyday engineering work one did not know what stresses would have to be borne. The high-speed fatigue tests of Professor Jenkin at Oxford, which showed a higher fatigue limit at 2,000 revolutions per second than at the ordinary testing speeds of about 2,000 per minute, indicated that there must be some viscosity effect.

Professor Andrew Robertson considered that the fatigue-testing machine developed by Professor Smith at Belfast some time ago had never received the recognition it merited. This machine, like the later one of Haigh, could be used to stress the specimen between different limits in either direction, which was not feasible in the Wohler machine. Tests between equal, plus, and minus limits were, however, the only ones which would demonstrate concentrations of stress, such as those occurring at the edge of a hole. For many cases, when economical designing was the object, it was desirable to know the shape of the S–N curve for both equal and unequal methods of stressing. The high-temperature tests of Professor Lee were most interesting, and they indicated the possibility of carrying comparatively high stresses at high temperatures, as would be required in a gas turbine, although it would be necessary to be able to run safely through the low-temperature range. The work of Professors Moore and Jasper was also most valuable, and afforded material which would be required by anyone undertaking the consolidation of our knowledge of fatigue questions.

Professor G. W. O. Howe, the President of the Section, said that the possibility of an intensive short-time test which would indicate the behaviour of materials under a long-time test, was a problem which occurred in connection with the testing of electric lamps, thermionic valves and other apparatus. When the test was to determine some definite characteristic, the results of intensive short-time tests could be correlated with those of full-time normal tests, but otherwise the deductions were uncertain. At Glasgow University there were some corks placed on a basin of pitch by Lord Kelvin, some of which were now half-submerged, showing the effect of a long-continued small force on a hard though viscous material. Steel might also be viscous and if so there would be a time effect, and in such a case the wave form of the alternating stress must be taken into account, two alternating stresses of equal maximum intensity and equal frequency would give very different results according to their respective wave forms. Professor Lea agreed that the time factor was very important especially in high temperature tests and the question of viscosity deserved consideration.

Professor C. F. Jenkin did not find himself in agreement with Mr. Wilson's point of view. It was necessary to find the philosophical key to the whole of the phenomena, and until that was done it would not be possible to correlate the results. He thought that mild steel was an unsuitable material for investigation on account of its complex nature, and therefore he was experimenting with copper and other more homogeneous materials. With regard to Professor Robertson's complaint as to the neglect of Smith's work, it should be pointed out that Gough had freely acknowledged his indebtedness to it. The speaker could not follow Professor Ellis's remarks on the oil film analogy because it was generally believed by physicists that an oil film on water would stretch until it was one molecule thick. It was possible, theoretically, to calculate the tensile strength of steel from observations on its latent heat. Dr. Griffiths had studied the strength of glass and silica in attempts to discover wherein the strength of substances lay. He had actually made a glass rod which would withstand a tensile stress of 200 tons per square inch, this great strength being reached because of the total absence of inter-crystalline spaces. It was, however, necessary to protect the specimen by a coat of varnish, otherwise the minute scratches made on its surface by dust in the air weakened it.

Professor T. M. Jasper said that Professor Moore and he agreed that at least 10 million cycles should be used to determine a fatigue limit. In very hard steels two or three million were sufficient to show the existence of a limit. With regard to Professor Hudson Beare's remarks about the effect of different speeds of testing, he might say that at Illinois they had carried out tests at speeds ranging from 200 r.p.m. to 2,000 r.p.m. on the same machine and under the same conditions and the results bore out those obtained by Professor Jenkin, namely, that the endurance limit was higher with the higher speed. The possible effect of segregation in steel had been mentioned. With cast steel endurance tests had shown much "scatter" of the plotted points, whereas ordinary tests on mild steels gave points which fell on almost straight lines. The cast steel experiments therefore seemed to show that segregation did have an effect on endurance strength.

The Calculation of Quenching Stresses.

The morning session of the Engineering Section commenced on August 12 with Professor T. M. Jasper's paper on "The Calculation of Quenching Stresses in Steel by using Direct Measurements." This paper, which we hope to reproduce later, indicated that the initial stresses set up in steel by quenching were considerable. Fatigue testing had the effect of relieving these stresses. It was suggested that the maximum value of the initial stress might be taken with fair accuracy as two-thirds the difference between the elastic limit and the yield point, a sensitive extensometer being required to determine the latter values. It must, however, not be assumed that the best heat treatment of steel was that which gave the smallest difference between the elastic limit and the yield point. The elastic limit of a ferrous metal was not a good figure as the basis of design, the yield point or the ultimate strength being more reliable bases of a factor of safety.

The discussion was opened by Professor S. Timoschenko, who considered that the second method described by the author in his paper, namely, the measurement of the changes of length of the specimen after successive borings, was the more reliable one. The accurate measurement of dilatation was very difficult, but by measuring changes of length it would be possible to get more satisfactory results. There were types of internal stress not due to concentric layers of different material such as were formed by quenching, namely, stresses due to cold working. Professor Ellis remarked that Brinell had recorded peculiar results with water-quenched samples of steel. Not only had the yield point and tensile strength been found to be less than in normal steel, but they were also less than in oil-quenched steel. During the recent war he had carried out experiments in connection with the season cracking of cold-worked brass rods. Three-inch lengths of such rods were pierced by a slot $2\frac{1}{2}$ in. long through the centre, and the degree of opening of the slot was measured. Little correlation was found between the amount of opening and the tensile strength of the material.

Dr. J. S. Owens asked the amount of rise of temperature in the fatigue test and also remarked that the bulging of the end of the rod by an amount of the order of $\frac{1}{10,000}$ to $\frac{2}{10,000}$ of an in. seemed to be too small to measure with certainty. To base results upon such measurements was somewhat doubtful. Sir James Henderson asked on what foundation the theoretical stress distribution was based.

The ordinary formula for the stress in a thick cylinder was based upon the fundamental assumption that there was no axial strain, which was not justified in the present case. Professor G. Cook remarked on the difficulty of removing initial stresses, and wondered whether Professor Jasper could remove them entirely by annealing. The speaker had once required a small steel bar bored out to form a tube about $\frac{1}{10}$ in. thick. The machining was done with every possible care, but after a day or so the tube had become so distorted that it was useless for the purpose intended. He agreed with the author of the paper as to the non-importance of the so-called elastic limit.

Professor F. C. Lea hoped that Professor Jasper would say more about his extensometer. He was more inclined to agree with Professor Jasper than with Dr. Owen on the question of the possible accuracy of measurement. Of course, suitable precautions must be taken, and he had, when making experiments on the modulus of elasticity, worked at night and so arranged matters that he never had to go within 20 ft. of the apparatus, so as to avoid temperature troubles. Regarding the question of taking the yield point as the basis of design, as advocated in the paper, in nickel-chrome steels and heavily-worked steels, there seemed to be no definite yield point. In cold-worked material there was a low elastic limit, and this limit, or the limit of proportionality of stress and strain, should, he thought, be used in preference to the yield point.

Professor Jasper, replying to the discussion, said that the initial experiments were made with steel of very low carbon content in order to get rid of the effect of carbon in altering the bulk of the quenched steel.

He had had no way of measuring the temperature produced in the specimen by the fatigue test, but it burnt one's finger when touched and was therefore quite hot. It was very difficult to be sure that all internal stress in a material was removed by annealing, as those who were familiar with the annealing of glass would agree. The absolute accuracy of his extensometer might be questioned but all that was wanted was a thoroughly sensitive and consistent instrument, and he believed its accuracy to have been within the limits necessary to give reliable results. He would have brought the instrument to the meeting had it not been for Customs difficulties.

The Large Deflection of Circular Plates.

Following Professor Jasper's paper, Professor S. Timoschenko contributed a short note entitled "The Large Deflection of Circular Plates." He mentioned that the usual formula for the deflection of a circular plate, uniformly loaded and rigidly held round the circumference, was

$$w = c\left(1 - \frac{r^2}{a^2}\right)^2$$

in which w denoted the deflection at any radius r, a was the radius of the plate, and c was the deflection at the centre of the plate.

This formula was true for small deflections. If the deflection was greater, the thickness t of the plate had to be taken into account, and c in the formula had to be replaced by the value c_1 which was given by the expression

$$c_1 = \frac{c}{1 + 0{\cdot}488\left(\frac{c_1^2}{t}\right)^2}$$

It was pointed out by Professor C. F. Jenkin that the formula led to the deduction that as the amplitude of the motion of a telephone diaphragm increased, its natural frequency would increase.

The Relationship between Tests on Notched Bars of Different Sizes.

The next paper was one by Professor H. P. Philpot entitled "The Dimensional Problem and the Significance of the Notched Bar Impact Test." The standard Izod test piece adopted in the Air Force specifications is 10 mm. square with a 45 deg. vee notch having a radius of 0·25 mm. at the base of the notch. The thickness of metal behind the notch is 8 mm. The test piece is held in the vice of the machine close up to the notch, and the notched face of the projecting end is struck by the pendulum at a point 22 mm. above the centre of the notch. The test figure is the amount of energy measured in foot-lb. which is required to break the specimen. As it is not possible to cut test pieces of the standard size from many of the articles to which it is desirable to apply the Izod test, Professor Philpot conducted a series of experiments with a view to correlating the energy absorbed in the fracture of pieces of different sizes with the dimensions of the pieces. In all cases he used a notch of the standard form. His test pieces, which were all cut from the same bar of steel and subjected to identical heat treatment, varied in breadth b; in striking distance from the notch, l; and in thickness at the notch t. His final conclusion was that U, the breaking energy in foot-lb., could be expressed with sufficient accuracy by the empirical formula given below, the dimensions being in millimetres. The values given by this formula agreed generally with the mean of the respective test results within a limit of one foot-lb.

$$U = 0{\cdot}609\,b\,t\left(\frac{t^2}{l^2} + 0{\cdot}135\right)\left(l + 25\right).$$

The author suggested that the best method of applying the formula to actual testing procedure was to evaluate it both for a standard test piece and for some actual test piece, and use the ratio between the two values as a "dimensional coefficient" relating to the actual test result.

The discussion on Professor Philpot's paper was very brief, Professor E. D. Allcut complimenting the author on the careful work necessary to the production of the paper and remarking that the work both of Professor Philpot and of Charpy had shown that the notched bar test gave results with a variation of less than 3 per cent. provided that proper care was taken in applying it and in preparing the specimen.

Report of the Complex Stress Committee.

The Committee of the British Association, which has been sitting for several years to investigate "certain of the more complex stress distributions in engineering materials," submitted as its report eight independent papers having little or no connection with each other. This was somewhat disappointing to those who had hoped that the time had come when the Committee as a whole could have presented a report which would at least have crystallised the existing state of knowledge and made it clear what facts they could agree upon in connection with questions of the failure of metals under fatigue, shock, or steady stress. The papers presented as the report of the Committee were as follows: "Photo-Elastic Methods of Testing," by Professor E. G. Coker; "A Standard Form of Test Piece," by Professor W. E. Dalby; "The Impressed Conditions of Fatigue Tests," by Dr. A. A. Griffiths; "The Influence of Circular Holes on the Fatigue Strength of Hard Steel Plates," by Professor B. P. Haigh and Mr. Albert Beale; "The Distribution of Stress in Fatigue Test Pieces (Torsion and Bending)," by Professor W. Mason; "The Effects of Inaccuracy of Axial Loading," and "The Drop of Stress at the Yield Point of Ductile Materials," by Professor Andrew Robertson; and a "Note on Impact Experiments," by Mr. R. V. Southwell.

Of all the authors, the only one present was Dr. Andrew Robertson. There was little or nothing that was novel in the report. In the first paper, Professor Coker pointed out the increase of stress due to the curvature at the shoulders of a test piece and also pointed out that a small local "pinch" such as that exerted by the points of the holding screws of an extensometer might be serious. He further proposed the alteration of the standard cement test piece so that it should have a short parallel part at the centre instead of its present waist. Professor Dalby advocated the provision of flanges 5 inches apart round the central part of an ordinary tensile test piece, the existence of which would enable an extensometer to be attached more satisfactorily. Repeated experiments had led to the conclusion that the extensions of the test length were not materially affected by the existence of the flanges. Dr. Griffith pointed out that as one or both the fatigue limits usually lay outside the limits of proportionality, and further, that the limit of proportionality was a function of the previous history of the specimen, it followed that the results obtained with the various kinds of fatigue-testing machines now in use were not comparable, as the stated stress limits did not represent actual stresses in the material.

The paper by Professor Haigh and Mr. Beale showed that the limiting stresses for fatigue of a drilled test piece 1·5 in. wide varied only slightly when the central hole varied between 0·0365 in. and 0·200 in. diameter. The effect of the hole, according to the theory of elasticity should be to increase the stress in the plate to three times its nominal amount, but the plate behaved in practice as if the stress was only increased to 2·15 times the nominal amount. The material used was cold rolled high tensile steel strip and was tested on a Haigh machine at 2,000 cycles of stress per minute. Professor Mason's contribution discussed the effect of the fact that steel would endure many millions of alternations of stress with accompanying hysteresis too great to be compatible with elasticity. Professor Robertson described the form of shackles he had devised to prevent the bending of materials in a tensile testing machine, and his method of mounting specimens for compression tests. His tension shackles were illustrated in Engineering of December 15, 1911, and their use has enabled more reliable and consistent results to be obtained, especially with very small specimens. Dr. Robertson also described his method of investigating the yield point of materials under tension by mounting extensometers on long tension rods in parallel with the specimen. Mr. Southwell's note on impact experiments referred to the effect of the mass and rigidity of the Izod testing machine on the results obtained. He suggested that notched bar tests should be replaced by an impulsive torsion test applied to a specimen of hour-glass shape, and indicated the type of testing machine he proposed for the purpose.

The discussion on the Report of the Complex Stress Committee was very brief and was confined to remarks concerning the desirability of, and the means whereby, axial loading of test specimens could be secured. The discussion was followed by a paper on "Some Comparative Fatigue Tests," by Messrs. H. F. Gough and H. J. Tapsell. The paper, which had only reached the secretary the previous day, was presented by Professor C. F. Jenkin, in the absence of the authors, but gave rise to no discussion.

The Engineer and Public Health.

On Wednesday, August 13, proceedings were commenced by a paper by Mr. F. A. Dallyn, entitled "The Engineer and Public Health." The object of the paper was to suggest that such services as the supervision of public water and milk supplies, sewage disposal, river pollution, refuse collection and destruction, the extermination of rats, flies, mosquitos and other pests, and other duties should fall more largely into the hands of the engineer, leaving the medical health officers free to concentrate on questions concerning their own profession. The real interest of the paper to the audience lay, we believe, in the facts, illustrated by innumerable lantern slides, concerning the pollution of the Great Lakes and waterways by sewage, and the measures which had, therefore, become necessary to safeguard public health. The Great Lakes and waterways are used both as drinking water supplies and as places for the disposal of sewage for the cities along their shores. An agreement between Canada and the United States in 1909 stated that neither nation should pollute the waters in a manner injurious to the other, and an International Commission, subsequently appointed, has investigated the whole question in view of the prevalence of typhoid fever in Chicago and other lake cities. One outcome of the report of this Commission was the general adoption of the practice of chlorinating drinking water supplies about the year 1913, and the sudden and striking drop in the typhoid rate which followed was shown by tabulated figures on the screen. Recurrent outbreaks of typhoid in the communities living around the Sault St. Marie Canal had been attributed to flies having access to fæcal matter, the water not being suspected as there was no obvious sewage discharge anywhere near the intakes. Investigations had shown, however, that the water was highly polluted by the great quantity of shipping which concentrated in that neighbourhood, and when chlorination was introduced the typhoid rate almost vanished. A further point of interest was the author's reference to the diseases due to iodine deficiency. An examination of 47,000 school children in Cincinnati had shown that 26 per cent. were suffering from disabilities due to lack of iodine, and a minute quantity of this substance was now being added to the public water supply in certain areas.

"The Bio-aeration of Sewage."

Mr. J. D. Watson's paper on "The Part Bio-aeration may yet Play in the Disposal of Sewage" was read by Professor F. C. Lea in the absence of the author. We reprinted the paper in our issue of August 15. On its conclusion, the President invited remarks bearing either upon it or upon the previous paper of Mr. Dallyn, and Mr. W. Gore, speaking from an extensive practical experience of the water and sewage problems of the Great Lake cities, said their difficulties arose from "discharging their sewage into the same pot as they drank from." The statistics thrown on the screen showed that Toronto had a perfectly satisfactory position as regards typhoid and other waterborne diseases, yet he had known the raw water polluted to the extent of 100,000 B. Coli in a single drop. Polluted water could reach the intakes from the sewage outfall 5 miles away, when the wind was in the right direction, but the system of filtration and chlorination employed prevented any outbreak of disease.

"Cobalt Magnet Steels."

The next paper was one by Mr. E. A. Watson, entitled "Cobalt Magnet Steels," which described the improvement in the magnetic qualities of steel by adding cobalt, and discussed the commercial value of the practice. We commenced to reprint the paper in our last issue and complete it in this. The author showed that the technical value of a steel from the magnetic point of view did not depend either upon the remanent flux B_{rem} or the coercive force H_c, nor upon the product of these two quantities, but upon the maximum value of $B \times H$, which was called BH_{max}. This was the figure of merit for a steel, as it was a measure of the maximum energy which the magnet could provide in a circuit external to itself. The effect of adding increasing percentages of cobalt to pure iron was to increase the intensity of magnetisation from 1,700 for pure

NEW ZEALAND PAVILION AT THE BRITISH EMPIRE EXHIBITION.

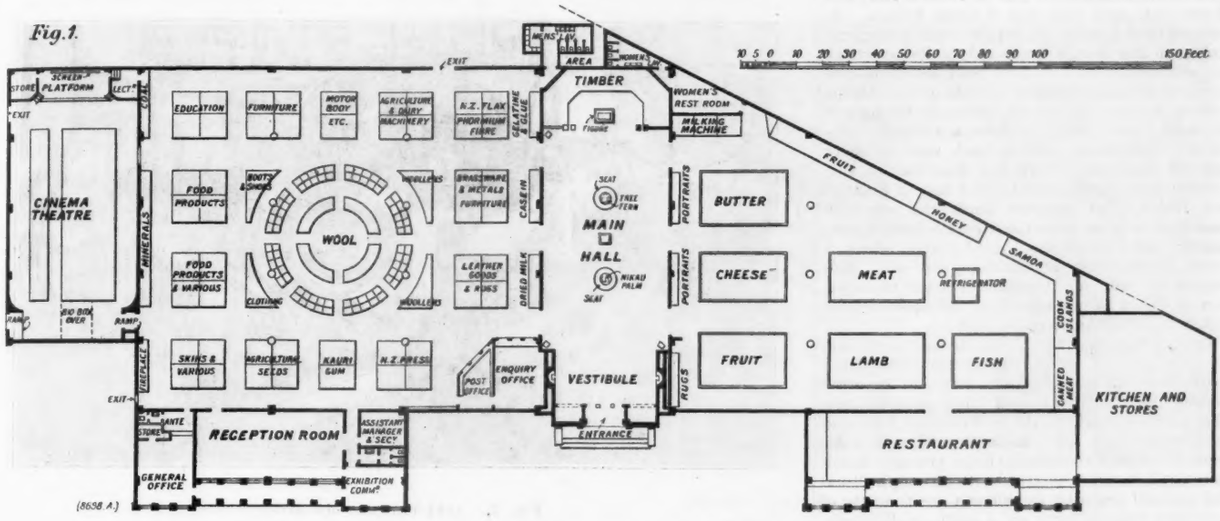


FIG. 1. GENERAL PLAN OF THE PAVILION.

iron to 1,900 for an alloy containing 35 per cent. of cobalt. The intensity of magnetisation then gradually decreased to 1,200 for pure cobalt. The paper is worth detailed study by all who are interested in the design of permanent magnets, on account of the systematic presentation of the facts concerning the influence of cobalt. At the present price of cobalt, it appears that its use is hardly justified commercially, except perhaps in the case of high alloy steels, although a reduction in the price of cobalt would alter the situation.

In the discussion following the paper, Mr. R. S. Whipple considered that cobalt steels would find increasing usefulness in the manufacture of galvanometers and other instruments and apparatus where magnets had to be very light for their strength. Another speaker enquired as to the evidence for the existence of the compound Fe_2Co which was assumed by the author to exist. Did microscopical examination indicate the presence of any such compound, and if the magnetic properties of the steel were due to Fe_2Co, what sort of structure did the steel have? Professor F. C. Lea and other speakers discussed the question of hardening and annealing temperatures, and in reply to them Mr. Watson practically repeated the information he had given in his paper. With regard to the compound Fe_2Co, he stated that the only ground for believing that such an alloy existed was the evidence of a definite maximum on the magnetisation curve when the cobalt content was about 35 per cent., and this proportion of cobalt agreed with the molecular weight of the assumed alloy. So far as miscroscopic evidence went, the iron and cobalt appeared to form a solution at all percentages, this solution behaving exactly like iron. He was glad to hear that Mr. Whipple foresaw a future for cobalt steel in the manufacture of instruments, and mentioned that it had also been found valuable for the magnets of a high-tension generator for wireless work in which weight was of prime importance.

SOME NEW RECORDING INSTRUMENTS.

The final paper before the Engineering Section was a description by Mr. Robert S. Whipple of four new instruments for engineering research, namely, a graphical stress recorder, an accelerometer, a vibrograph and a torsion meter, all recent productions of the Cambridge Instrument Company. The torsion meter was of the Moullin type, illustrated in ENGINEERING of June 13 last, so that we need not refer to it further than to mention that it is an electrical instrument, the torsion of the shaft under load altering the position of iron cores in relation to choking coils and thus altering the current flowing through the electric circuit. It will work without attention in the tunnel of a ship or elsewhere, and the recording instrument can be located in the engineer's cabin or other convenient place. The Cambridge stress recorder is designed for attachment to the members of a bridge or other structure, to obtain a record of their deflection under a passing load, and thus to check the strength of the structure. The diagram is drawn by a hardened stylus on a strip of celluloid which can be traversed by clockwork at different speeds, and the record, which is ten times the amplitude of the actual deflection or vibration, is enlarged photographically to a total amount of 150 or 300 diameters. When an observation only is needed, the record may be examined by a simple portable microscope. Some very striking records of the strains of a ship at sea, and of the vibration of a railway bridge were shown on the screen.

The Cambridge accelerometer was primarily designed for measuring the acceleration of motor cars, aeroplanes and lifts, and for studying the effect of springs in road vehicles. It comprises a heavy mass attached by spring steel strips to a fixed frame and carrying a stylus which makes a record on a celluloid strip, moved by clockwork. A magnetic damping device checks the motion of the weight and makes the instrument practically dead beat. The Cambridge vibrograph is really a kind of seismograph, making its records on a celluloid film as in the case of the other instruments. Records of the vibration of a road due to the passage of a motor-bus, and of a steam turbine in a power station, were shown. These instruments we hope to illustrate and describe more fully in due course.

The paper on "An Economical Design of Arch Centres," by Mr. A. E. Wynn was taken as read, and the paper on "The Future of Power from Fuel," by Mr. E. Kilburn Scott, was cancelled, neither the author nor the paper being present.

(To be continued.)

NEW ZEALAND AT THE BRITISH EMPIRE EXHIBITION.

IN the accounts we have given of the exhibits of Australia, Canada, and South Africa we have had occasion to point out that an essential part of the purpose of each of these Dominions in taking part in the Exhibition was to make the inhabitants of Great Britain better acquainted than they were with the circumstances and conditions of Dominion life. Of no exhibiting State is this observation more true than of New Zealand, and the meaning of its exhibit may be understood more clearly if the Dominion's circumstances are shortly recalled. New Zealand is already linked with the United Kingdom by closer bonds of trade intercourse than any other country in the world. More than seven-tenths of its total trade is done with the United Kingdom, which takes over four-fifths of its exports and supplies over one-half its imports. It is second only to Australia in the quantity of wool it provides for our industries. It supplies us with more tallow than Australia, with not very far from as much mutton and lamb as the Argentine and Australia put together, and, measured in butter-fat, with more cheese and butter than any country in the world, in addition to large quantities of other products. In its purchases, it is giving an average preference of 15 per cent. to British goods over those of foreign countries, though it has to look to Customs and Excise duties for about one-fourth of its total revenue; and it admits free from this country a large variety of manufactures, such as bar steel and iron, electrical machinery and materials, industrial and agricultural machinery, pipes and tubes, cotton piece goods, printing paper and others, which are charged from 10 per cent. to 20 per cent. if from foreign countries. In proportion to its population New Zealand is, moreover, by far the most active external trader within the Empire. Its total trade per head is over half as much again as that of Canada or of the United Kingdom itself, and its trade per head with the United Kingdom is more than double that of Australia and more than three times that of Canada.

Though the territory of New Zealand is small compared with those of Australia, Canada or South Africa, it is, in fact, considerably larger than that of Great Britain. The population that has attained the remarkable commercial position to which attention is drawn above, now numbers about 1¼ million souls—about as many as are in Buda Pesth, less than half the population of Paris, and less than one-third that of Berlin. This population is almost exclusively British. The intelligent and cultivated Maori natives number only about 5 per cent., and of the white population nearly 99 per cent. are of British parentage, and about half the remainder are naturalised. They are distributed over the country more uniformly than either the population of the United Kingdom or of other Dominions, and indeed they have much to attach them to their homes. Though it is some 13,000 square miles larger than Great Britain, New Zealand is about twice as long, and the sea has a correspondingly greater influence on its climate. There is, moreover, an abundance of mountainous territory, occupying about a tenth of the surface of the North island and a still larger proportion of that of the south. The snow line is 3,000 ft. or more lower

than in Switzerland; two glaciers within ten miles of the sea descend as low as 700 ft. above sea level. The rainfall is abundant and well distributed, and the mean sunshine only a little less than that of Italy and 50 per cent. more than that of Great Britain. As compared with London, the highest summer temperature is, on the average, lower and the lowest winter temperature higher. Animals need not be housed during winter, and in many districts in both islands flowers of some variety are blooming throughout the year; some, such as roses, are almost evergreen. The mean general death rate is under nine per thousand—a little less than that of Australia and only about two-thirds of that of England and Wales. The infantile death-rate, which is steadily decreasing, is, on the latest available figures, exactly half that of the United States, which is about 10 per cent. higher than our own; and though the rate for Australia is lower than our own by about 25 per cent., it is still about a third higher than that of New Zealand.

As may be judged by the summarised particulars given above and as will appear in more detail below, the inhabitants of this rich and beautiful country have not neglected their opportunities. They have occupied two-thirds of the land, traversed the country from north to south with over 3,000 miles of railway, developed large primary manufacturing industries concerned with their agricultural and pastoral products, as well as a great variety of secondary manufactures on a much smaller scale. They are beginning to harness their considerable water power, and, per head of population, the shipping entered and cleared at their ports, though a little less than that of Canada, is one-third more than that of the United Kingdom and two-thirds more than that of Australia. Nevertheless, it is beyond the power of the 1¼ million population of New Zealand to do full justice to their country. Without counting the land still remaining to be occupied, a considerable part of which could be developed to similar advantage to that which is already being worked, much more could be made if more workers were available. It is certain, moreover, that in the need of most European countries for an outlet and larger opportunities for their congested and increasing populations, the attractions of New Zealand cannot escape notice, and the required immigration will arrive from other countries if it is not supplied by our own. Not less than any other Dominion, and more than most, the inhabitants of New Zealand are of the purest British origin, and certainly more than most retain a purely British temperament and are attached to British traditions. Their exhibit at Wembley is the work, not of the individual firms whose products are shown, but of the State; and it may well be believed that its primary purpose is to do what is possible to ensure that the fellow workers who must in increasing numbers share with them the blessings of their country shall be of the like blood and temperament to the present New Zealanders, and attached to the same traditions as they cherish themselves.

We have already given a brief description of the New Zealand Pavilion, and Fig. 1, on p. 287, is a plan of its lay-out, designed by the Advisory Architects to the New Zealand Government, Messrs. Llewellyn E. Williams and John T. Mair. The exhibits represent a production of which complete statistics are not available, but the portion exported is of a value lying between 40,000,000*l.* and 50,000,000*l.* a year. Of this about 3,000,000*l.* are minerals, in addition to a substantial production used in the Dominion itself. The value of the exports in the metal working industries is not large, but their relative importance may be gauged roughly by their production, which is something under 5,000,000*l.* per year. In its own products, therefore, New Zealand is not directly a considerable factor in the engineering industry of the world or the Empire, nor is its mineral wealth comparable with that of some other Dominions. Its agricultural and pastoral products and the industries that depend directly on them are, however, indirectly of considerable engineering interest. They cannot be conducted to their best advantage without the help of engineering manufactures, and although the Dominion's own works are supplying this help to some extent, they have not yet reached the dimensions that will satisfy even the needs of the present population. All

NEW ZEALAND AT THE BRITISH EMPIRE EXHIBITION.

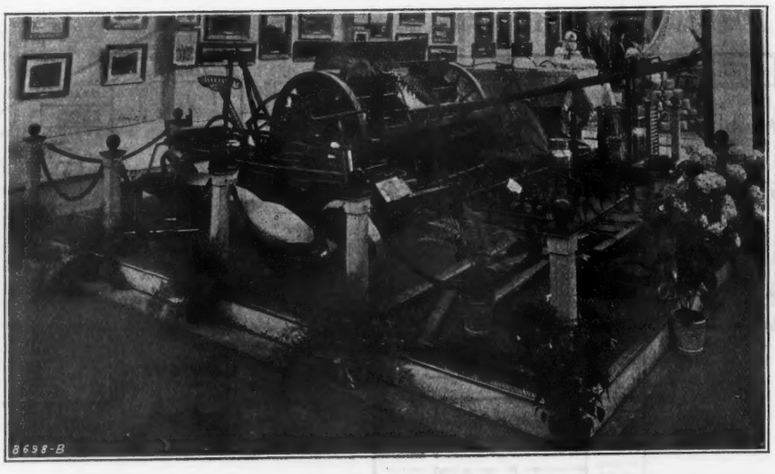


Fig. 2. Agricultural Machinery.

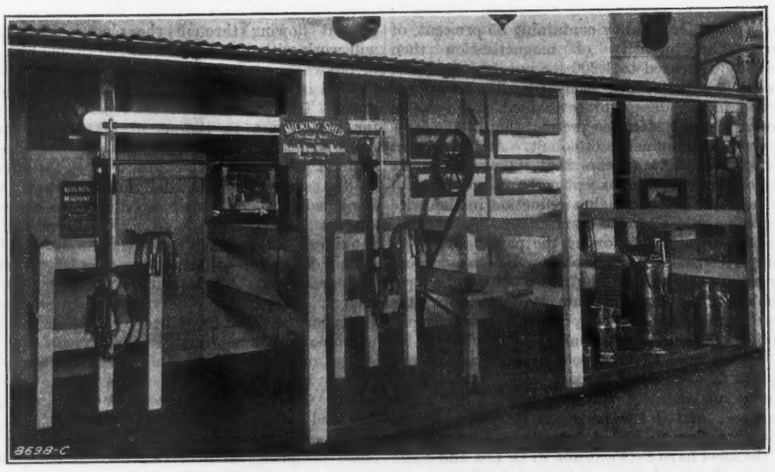


Fig. 3. Dairy Machinery.

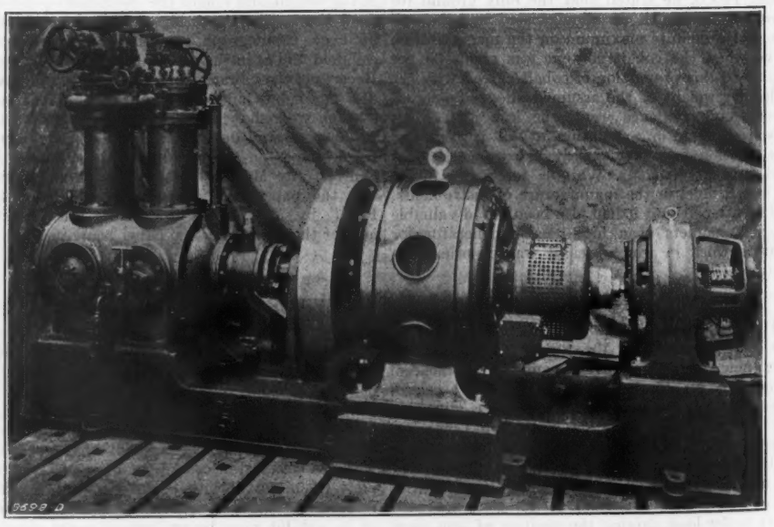


Fig. 4. Refrigerating Machinery.

NEW ZEALAND AT THE BRITISH EMPIRE EXHIBITION.

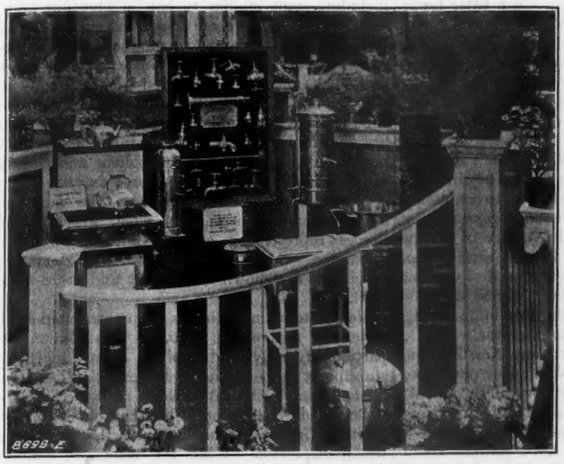


FIG. 5. COAL RANGES, GAS STOVES, &c.

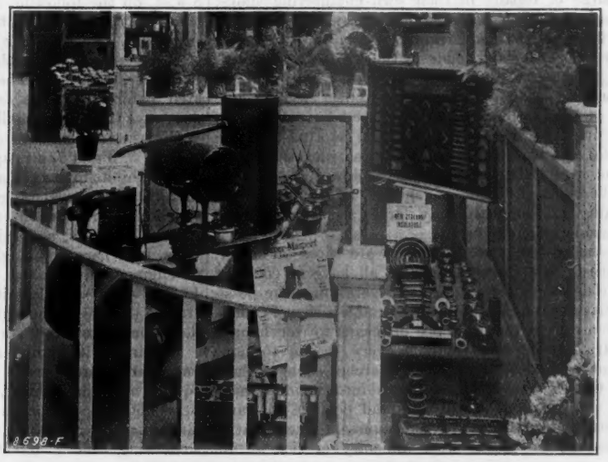


FIG. 6. OIL ENGINE, SWITCHGEAR, INSULATORS, &c.

FIG. 7. PRODUCTS OF THE METAL INDUSTRIES.

told, they employ only about 8,000 persons, a large proportion of whom are engaged on maintenance and repairs, and with the large works that the Government has in hand and the large scope that exists for additional mechanical assistance in their primary industries, the market of New Zealand appears to be among the most hopeful of those to which British engineering manufacturers can turn their attention.

To some extent this may mean more than offering existing designs. At one time, all, or most, of the machinery and appliances used in agriculture came from this country; but while those who used them found that in some respects British patterns did not suit local conditions, British manufacturers seem not to have understood what was really required, or to have been unwilling to produce it. Manufacturers in the United States were more accommodating and anxious, and appear to have obtained a large part of that portion of the business in machinery for these industries which is not produced by New Zealand manufacturers. It is, of course, the New Zealand works that have the best opportunities of studying local requirements, and Fig. 2, on page 288, shows examples of patterns produced to satisfy them. The machine in the front of the exhibit is a three-furrow plough, to be drawn by six horses. The design has been developed in New Zealand largely through the work done in the last twenty years by Messrs. P. and D. Duncan, who made the plough exhibited, and it is claimed that for dealing with a large acreage on level or easy downy land it is considerably more efficient than oil-tractor ploughing. Ploughs, for example, such as that which is exhibited are said to be ploughing 6 in. deep at the rate of 4 acres to 5 acres in 8 hours, as against $\frac{1}{2}$ acre to $\frac{3}{4}$ acre in a longer day in this country when a single-furrow, two-horse plough is used. Apart, moreover, from what may be described as general purpose ploughs for doing intensive work on ordinary land, advantage is found in special designs for dealing with types of soil that are met with in New Zealand, and are found to benefit by special treatment. Thus, for example, there are large areas of stiff, clayey soil with a hard ironstone bottom that has to be broken up, and the best practice requires furrows that may be as much as 12 in. deep and of such dimensions that the sub-soil is really mixed with the surface soil. Such ploughs have been produced in New Zealand, and are used with great advantage both for ploughing swamp or scrub land and opening the surface for pipe drains. The other machine shown is a grain, seed and manure drill of a type very frequently used.

Another industry that in New Zealand depends largely on appropriate machinery is that of dairying. The practice, for example, of milking cows mechanically, instead of by hand, is widely spread. Already over 13,000 machines are in use, dealing with a majority of the milch cows in the Dominion, and the number is increasing rapidly. A variety of designs are used, and it is claimed that with a two-cow machine a man and two lads can milk 100 cows in 100 minutes. While the machines differ in detail, their general style and lay-out is shown fairly in the exhibit of which a view is given in Fig. 3. In substance they provide a cup for each teat of the cow, and by a suitable mechanism the extent of the pulsation and vacuum is regulated so that each cow is treated similarly. The milk runs through a pipe line to a releaser, which may be in another part of the building and is, in fact, in the nature of a flap valve, whence it is delivered either to the separator or to another receptacle to be treated whole. The remarkable expansion of the dairy industry is attributed in large measure to the great use that is made of mechanical milking. In a well-found dairy, the use of mechanism and mechanically-produced utensils goes, of course, considerably further. Many are driven by electricity; the use of pasteurising plant and centrifugal separators is very common, if not invariable—there are already over 40,000 separators in use, and the number is increasing rapidly—and in other respects all the usual range of dairy machinery is employed.

The large scale, moreover, on which butter is made and the consequently great volumes of skimmed milk that are available, has created an industry of casein, in the manufacture of which the curd is baked hard in ovens and has then to be ground, whether it is used ultimately in a solid or a liquid form. A similar use of whole milk is made in the preparation of dried milk, where the powder is a desiccated spray, in the preparation of which fans and sifters are indispensable. There are no great factories of tins in New Zealand that can supply

the needs of the large dairies, and some of these accordingly have modern tin-making machinery from which they supply their own entire needs out of tinplates imported from this country taking charge of repairs in their own engineering shops. Similarly, they have box-making shops equipped with the most modern machinery; unfortunately, for the most part, made in the United States.

A separate exhibit is made of casein and its derived products. Glues are shown which have a peculiar strength, and are used successfully in cabinet making and joinery, and as a paste. The solid casein products, appearing as imitation ivory and in similar forms, are well known, and a good collection of them is shown. Here again the industry, though already large, seems capable of considerable extension.

Among the largest exhibits are those of butter, cheese, meat and fish, which all have in common the necessity for accurate refrigeration. The possibility of export trade in these products has, of course, been due to the existence of means for mechanical refrigeration, and there is every reason to hope that with the progress of researches such as those of the Food Investigation Board into the mechanism of refrigeration, it will be found possible to transport, under refrigerated conditions, products that at present can travel with difficulty or not at all. For the time being, indeed, designers of refrigerating machinery have produced all that users are in a position to demand, and the ball lies with the biologists. Whatever may be their next requisition, there is no reason to doubt that engineers will be equal to satisfying it; and in the meantime, as has been seen in the Pavilions of the other Dominions, and elsewhere in the Exhibition, a very high standard has been reached in the manufacture of refrigerating machines. The six cold stores or cabinets in the Pavilion occupy 27,870 cub. ft., and with a frontage of 416 ft., have a clear window area of 2,500 ft. This is insulated with four thicknesses of plate glass, and a curious circumstance of this arrangement is that, to counteract the slight but cumulative green tint of the glass, suitable internal coloured lighting has had to be provided, with tints varying according to the nature of the product. These lamps take in all 7 kw. per cabinet, and the energy thus generated is, of course, added to the duty required of the refrigerating plant.

This plant has been lent and erected by the Haslam Foundry and Engineering Company, Limited. The machine is one of their enclosed vertical duplex 8-in. by 8-in. ammonia compressors running at a speed of 333 r.p.m. and connected through a flexible coupling to an auto-synchronous motor by Messrs. Crompton and Co. This compressor (Fig. 4) consists of two single-acting cylinders with ring plate valves machined from solid alloy steel, specially heat treated to work for long periods without pitting or replacement. The valve system is designed to reduce both the clearance and the gas speed to a minimum figure, and the valves, like the oil filter in the crank case, are arranged so as to be accessible without disturbing the pipe joints. The workmanship throughout is of a high quality, the cylinders being guaranteed true for bore and parallelism to two-thousandths of an inch. The connecting-rods are of heat-treated nickel steel, so as to reduce the weight of the reciprocating parts to a minimum, and arrangements are made for forced-lubrication by a gear pump driven off the crank shaft.

With condensing water at 60 deg. F. and brine cooled to 15 deg. F., the machine is rated to eliminate 560,000 heat units an hour in cooling from 60 to 40 deg. F. In the present installation, the cheese and fruit cabinets are kept above freezing point, and the butter, meat and fish cabinets well below it. The cabinets are cooled on the loft system, with central downcast and upcast at the sides. Except in the fruit cabinet, where some fresh air has to be introduced from time to time to balance the increase of carbonic acid in the atmosphere evolved by the living fruit, no fan is used. Separate freezing and chilling brine systems are provided, each with its own direct coupled brine pump, supplied by Messrs. Mather and Platt, Limited. Although the light in the cabinets goes on until the close of the Exhibition at 10 p.m., the refrigerating machine and brine-circulating pumps have to be shut down an hour before sunset; and, to prevent the consequent rise of temperature, large welded-steel brine drums are provided in the lofts, the brine system being proportioned so amply that the temperatures at 8 a.m. on the following morning are a little lower than they were when the brine circulation was stopped. Long distance as well as dial thermometers are provided by the Cambridge Instrument Company, Limited. The lay-out of the refrigerated exhibit, with its cabinets, passage-ways and doorways to the main hall, was designed by Mr. Hal Williams.

Figs. 5, 6 and 7, on page 289, show a variety of other exhibits in metal manufactures. They include, as will be seen, coal ranges and gas stoves, steam sterilizers for instruments and dressings, geysers, plug valves, hydrants, a considerable variety of hollow ware, iron bars and angles of various sections, an oil engine and insulators and switches designed for 11,000 volts. The last item is of interest as illustrating the present activity of the Dominion in the development of its hydro-electric power.

Leaving Switzerland out of account, New Zealand has a larger provision of available water power per square mile than any other country in the world; nearly 50 horse-power, as against about 5 for Great Britain. Of its total potential horse-power—something under 5,000,000 horse-power—about 30,000 horse-power has actually been harnessed. The development in question only began, however, within the last twenty years, and plans have already been made for increasing it up to something under 200,000 horse-power in the next six years. The supply that has been provided already has been taken up eagerly, not only for domestic but for industrial purposes. At present the water power provided is at the rate of about one-sixteenth of a horse-power per head of population, as against one-third of a horse-power in Canada and the United States, and the programme now contemplated will bring the developed water power capacity up to about one-fifth of a horse-power per head of the estimated population when the work is completed. There is, accordingly, *prima facie* reason to expect that even the provision that is being made is well within the needs of the population, and this view is borne out amply by the experience gained from the plants that have been completed. Milking machines, for instance, are run mostly on benzine engines, but in 1922 about 550 of them were taking their power from hydro-electric stations, and the number had doubled by March, 1923. In other respects dairy farms are a useful and widely distributed load, and the great pastoral industry with its large and increasing freezing works seems to offer a demand that will not easily be satisfied. The mining industry and many others are also substantial customers. The cost of energy, including amortisation, is nearer one-third than a half of that of electric energy produced by steam, which is very much cheaper than when produced by gas or by oil; and although load factors are by no means unsatisfactory, it is hoped that, with increased development of hydro-electric power, uses for it will be found which will further improve the load factor and cheapen the cost.

The mineral industry of New Zealand, though by no means unimportant, is not of the same order of magnitude as its agricultural and pastoral products. More than half of its total value is coal. Gold to the value of over half a million a year is now being produced—a considerable falling-off from the best earlier years—and nearly as large an income is derived from Kauri gum, found mainly in a fossilised condition, but to some extent bled from trees like rubber. Specimens are shown of a variety of ores and minerals, which indicate some deposits that may ultimately have a commercial value; but apart from Kauri the mineral resources of the country consist mainly of limestone and building materials of various sorts, which are used in the Dominion itself. The exhibit of Kauri is instructive as showing the various grades in which it is found and produced.

Nearly one-fifth of New Zealand is forest land, of which it is estimated that about one-half the timber is merchantable, and rough and polished specimens of the Dominion timbers are exhibited. The New Zealand "soft woods"—Kauri, red pine and white pine—are usually much harder and denser than the pine mostly used in Great Britain, and constitute the large majority of New Zealand production. There are, however, considerable quantities of beeches and other hard woods, including some similar to oak or chestnut and to lignum vitæ. There are many sawmills and other wood-using industries, which produce over 7,500,000*l.* worth a year, excluding the timber used in wooden buildings, and it is expected that some of the soft woods will be available for paper making. Of the furniture and similar industries many specimens are shown, notably a billiards table, piano, violins and furniture of all sorts. Woollens and clothings are also made and shown to some extent.

Next to refrigerated products the most conspicuous exhibit is that of wool, which includes fleeces representing every grade grown in the Dominion. Some tanning is also done, and specimens are shown of saddlery and other leather work.

Very interesting exhibits are contributed by the education authorities, who, in New Zealand, are particularly active and helpful. From a mechanical standpoint the exhibits of the Auckland Grammar School and Technical College and the Technical Colleges of Wellington, Christchurch, Palmerston North, Timaru, Dunedin and Invercargill, are worth inspection. While the scheme of education is broad, some mechanical instruction is given even in the primary schools, as is shown by an exhibit of metal work from Auckland.

An important exhibit is that of New Zealand flax, derived from a special variety of plant, which yields an unusually fine and strong fibre. The machinery for milling this fibre has hitherto been made in New Zealand. The industry is considered likely to increase as the quality of the product gets more widely appreciated.

Taken altogether, the Pavilion indicates that, up to now, New Zealand has devoted by far the largest part of its attention to its primary products and the manufactures that exploit them directly. Though these have already been developed to an amazing extent, shortness of population and capital have prevented all from being done that might have been, and for a long period ahead this production is likely to increase. Secondary manufactures, including those in the engineering trades, have started, and the extent to which they will go on must depend on the extent to which manufacturers in this and other countries are able and willing to supply what is required to better advantage than it can be produced in the Dominion. There seems evidence that up to now as much has not been done to use the opportunities of this rapidly-growing market as might have been, and the loss of trade involved in this policy will grow rapidly more considerable as the hydro-electric development of the Dominion extends. Not only in prime motors and in alternatives for the various mechanisms already used, but also in fresh machines addressed particularly to purposes that would improve load factors, there seems to be a considerable opportunity both at present and in an extended future.

Australian Trade in June.—The total values of the goods imported into, and exported from, Australia during the month of June, 1924, were 11,202,362*l.* and 7,217,412*l.*, respectively. The latter figure included 6,772,967*l.* worth of Australian produce.

The Yield of the Spitzbergen Coal Mines.—We are informed by the Northern News Service, of Christiania, that during the current season the Norwegians have produced from their coal mines in Spitzbergen between 250,000 and 300,000 tons of coal, or 15 per cent. of the whole annual consumption of Norway.

Contracts.—The General Steam Navigation Company Limited, of London, have placed an order with Messrs. J. Samuel White and Co., Limited, East Cowes, Isle of Wight, for the building of a fast paddle steamer for their summer passenger service between London, Margate and Ramsgate. The vessel, which will be 300 ft. in length, will be fitted with all the latest improvements for the convenience and comfort of passengers and will be built under the supervision of Mr. William Gray, London, the naval architect and consulting engineer to the company.—We learn that the Becco Engineering and Chemical Company, Limited, of 158–160, City-road, London, E.C.1, have secured two further repeat orders from the Gas, Light and Coke Company for water-softening plant to be installed at Beckton and Nine Elms, respectively. The Beckton plant will have a capacity of 480,000 gallons a day and that at Nine Elms of 108,000 gallons a day.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Conditions are decidedly mixed in the steel and engineering sections. Heavy steel is uniformly depressed, with apparently little prospect of early improvement. Production of basic steel has suffered a great setback by the strike of operatives for district wages and conditions at three of the largest establishments. Close upon 40 open-hearth furnaces have been shut down, and output has been reduced to about one-quarter of its former tonnage. A certain measure of benefit has accrued to smaller firms producing material for rolling mills and forges, but on the whole consumers, in view of the general state of order books, show little disposition to contract forward. Stocks all round are exceptionally light, and the advent of a forward movement would immediately necessitate considerable purchases of semi-finished products. Compared with three months ago, makers of shipbuilding steel, heavy forgings, marine castings and turbine parts are doing an improved business, but, on the other hand, many of the orders placed some six or nine months ago for railway materials have been completed, and though conditions in the axle, tyre, and wheel departments are fairly active, the outlook is somewhat obscure. Bookings for crucible and other high-class steels are on a steadily improving scale. There is, however, considerable perturbation among firms operating furnaces devoted to the production of this class of steel respecting the effect of eight-hour day proposals. Local conditions are such that the operation of these would, it is contended, be economically impracticable, and would place products for which Sheffield is world-famous largely out of the market. Some of the lighter engineering branches are making steady progress, despite hostile tariffs, in consuming markets overseas. A considerable business on export account is being done in hack-saw blades. There is a steady demand for magnets of tungsten steel from British automobile engineers. Certain classes of small tools are also in better request now that German prices have been brought more to the level of those quoted by South Yorkshire makers.

South Yorkshire Coal Trade.—A seasonal improvement is in evidence in better qualities of house coal. Both country consumers and those in London are coming forward rather more freely for winter supplies. There is still, however, a substantial surplus of secondary qualities, recent reductions having failed to relieve the market. An improvement is reported in best steam hards. Home buying is maintained, while export users appear to be attracted by the lower rates ruling. Cobbles and nuts show a slight improvement, but smalls have declined an average of ninepence on the week. Quotations: Best branch hand-picked, 32*s.* to 35*s.*; Barnsley best Silkstone, 26*s.* to 28*s.*; Derbyshire best brights, 25*s.* to 27*s.*; Derbyshire best house, 23*s.* to 25*s.*; Derbyshire best large nuts, 21*s.* to 25*s.*; Derbyshire best small nuts, 15*s.* to 17*s.* 6*d.*; Yorkshire hards, 21*s.* 6*d.* to 22*s.* 6*d.*; Derbyshire hards, 21*s.* to 23*s.*; Rough slacks, 12*s.* 6*d.* to 15*s.* 6*d.*; Nutty slacks, 12*s.* to 14*s.*; Smalls, 6*s.* to 8*s.* 6*d.*

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—Depressed conditions continue in the South Wales coal trade, and new business is not sufficient to absorb even the restricted output of the collieries, despite the numerous stoppages which have been effected in consequence of a lack of remunerative trade. The outlook, moreover, is regarded as none too bright. In fact, Mr. W. North Lewis, Chairman of the Windsor Steam Coal Company (1901) Limited, told shareholders at the annual meeting that, speaking with a considerable experience of the coal trade behind him, he could not remember the time when the outlook seemed more unpromising. The agreement recently forced on the coal trade was burdensome in the extreme, and would, he believed, prove most disastrous to South Wales; not only to the owners, but also to the men. The agreement had only been in operation since May, but its effect had already been most seriously felt. Many collieries had had to shut down, at others men were under notice, and at many more the position was being viewed with the gravest alarm. It was quite impossible for this country to hope to compete successfully in the markets of the world, if they were to be handicapped by an excessive cost of production, brought about largely by working shorter hours and paying wages out of all proportion to their competitors. The slackness of trade is also affecting despatch to shipping, for, owing to the slow arrival of coal at the docks, some 30 vessels are waiting for landing berths. Meanwhile best Admiralty large coals are steady at 28*s.* 6*d.*, because of the shortened production caused by wholesale colliery stoppages, but all other grades are in excessive supply, with prices a matter of individual bargaining.

Iron and Steel.—Exports of iron and steel goods last week amounted to 15,674 tons, compared with 16,079 tons in the previous week. Shipments of tin plates and terne plates totalled 6,299 tons compared with 6,942 tons, black plates and sheets to 4,686 tons against 6,909 tons, galvanised sheets to 3,087 tons against 1,465 tons and steel goods to 1,602 tons against 263 tons.

FIRE WARNINGS.—We are in receipt of a card, drawn up by Dr. F. J. Waldo, H.M. Coroner for London, containing instructions relating to fires. All are warned against the dangers of gas leaks, chimney fires, and the common errors such as throwing water on burning oil. Copies of larger posters and cards may be obtained from the Town Clerk, Guildhall, London, E.C.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—In the Scottish steel trade one week is very much like another, and reports show that there is exceedingly little business passing this week. One or two establishments have a fair amount of work on hand, but no pressure for delivery is being experienced by almost any of the makers. Those who secured a number of contracts when conditions were better were extremely fortunate, as there is little buying now. In shipbuilding material there is an absence of demand, and the majority of orders being given out at the present time are mostly small and for current requirements only. Structural sections are not in much request either, and over all the outlook is rather dull. It was freely anticipated that prices would be lowered lately in view of the severity of foreign competition for anything required and in the hope of stimulating home business, but makers decided to make no concessions meantime, as little or no margin prevails at present, owing to the heavy cost of production. The inquiry both on home and export account shows no sign of expansion. The black sheet trade continues the brightest spot in the industry, and active conditions rule all round. Market quotations are as follow:—Boiler plates, 13*l.* 10*s.* per ton; ship plates, 10*l.* 5*s.* per ton; sections, 10*l.* per ton; and sheets, $\frac{1}{16}$ to $\frac{1}{4}$ in., 12*l.* 10*s.* per ton, all delivered, Glasgow stations.

Malleable Iron Trade.—No change of any kind falls to be reported in connection with the West of Scotland malleable-iron trade this week. Business is as difficult to secure as ever, and the prevailing hand-to-mouth conditions are most unsatisfactory and very disheartening to managements. The slight improvement in the re-rolled steel branch is fully maintained. Prices are unchanged with "Crown" bars called 12*l.* 10*s.* per ton, delivered Glasgow stations.

Scottish Pig-Iron Trade.—The state of the Scottish pig-iron trade has varied very little over the week. Movement has been limited, although one or two local consumers have been more inclined to purchase a little at to-day's quotations against their forward requirements. These lots do not amount to any heavy tonnage, and have not had any appreciable effect on stocks. Foreign dealing continues slow and inquiries are not very plentiful. The current quotations are as under:—Hematite, 4*l.* 16*s.* 3*d.* per ton delivered at the steel-works; foundry iron, No. 1, 4*l.* 18*s.* 9*d.* per ton, and No. 3, 4*l.* 13*s.* 9*d.* per ton, both on trucks at makers' yards.

Shipments of Scottish Pig-Iron.—The shipments of Scottish pig-iron from Glasgow Harbour for the week ended last Saturday, August 23, amounted to 694 tons. Of that total 617 tons went overseas and 77 tons coastwise. For the corresponding week of last year the figures were 280 tons foreign and 130 tons coastwise, making a total shipment of 410 tons.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Business in Cleveland pig-iron is on a very limited scale and values are weak, but sellers are hoping that autumn needs will prove larger than expected, and that the position will improve a little in the near future. On the other hand, buyers are holding off in anticipation of a still further fall in prices. Whilst stocks at makers' yards are stated to be well sold, customers are not taking out their full purchases, and make is in excess of present needs, so that the situation leaves a good deal to be desired. Though more is asked, No. 1 is obtainable at 89*s.*, and No. 3 g.m.b. at 83*s.* 6*d.* Foundry No. 4 is put at 82*s.* 6*d.*; and No. 4 forge at 81*s.* 6*d.*

Hematite.—The statistical situation in the East Coast hematite branch is unsatisfactory. Makers have heavy unsold stocks, which are being steadily added to. Sales are very slow and prices are distinctly easy. No. 1 is 93*s.*, and Nos. 2 and 3 at 92*s.* 6*d.*

Foreign Ores.—Little business is passing in foreign ore. Sellers are keen to make contracts on the basis of best rubio at 22*s.* c.i.f. Tees, and orders could probably be placed on lower terms.

Blast-furnace Coke.—Durham blast-furnace coke is very quiet, local consumers being disinclined to buy ahead to any extent. Good average qualities run from 25*s.* 6*d.* to 26*s.* delivered here.

Manufactured Iron and Steel.—Sheet makers keep very busy and report continued heavy inquiry, but almost all other branches of manufactured iron and steel are characterised by extreme quietness. The export price of galvanised corrugated sheets is fully 18*l.* 10*s.*, and black sheets are firm at 13*l.* A few small overseas orders for other articles have been booked at low figures. Export prices are still matters of individual negotiation, but the following are still the recognised market figures for home trade, though in some cases lower prices have been taken: Common iron bars, 12*l.* 10*s.*; iron rivets, 14*l.* 5*s.*; packing (parallel), 9*l.*; packing (tapered), 12*l.*; steel billets (soft), 8*l.* 10*s.*; steel billets (medium), 9*l.*; steel billets (hard), 9*l.* 10*s.*; steel boiler plates, 13*l.* 10*s.*; steel ship, bridge, and tank plates, 10*l.* 5*s.*; steel angles, 10*l.*; heavy sections of steel rails, 9*l.*; and fish plates, 13*l.*

THE STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Until lately having headquarters at 1, Bescot-road, Walsall, the Staffordshire Iron and Steel Institute has now removed to 74, Persehouse-street, Walsall.

NOTICES OF MEETINGS.

THE INSTITUTION OF RUBBER INDUSTRY.—Monday, September 1, at 8 p.m., at the Engineers' Club, Coventry-street, W. "The Acidity of Raw Rubber," by Dr. G. Stafford Whitby.

THE IRON AND STEEL INSTITUTE.—Autumn Meeting.—Thursday, September 4, and Friday, September 5, in Conference Hall No. 3, British Empire Exhibition, Wembley. Preceded by a Reception by the President and Lady Ellis at Princes' Galleries, Piccadilly, W. 1, at 9 p.m., on Wednesday, September 3. Thursday, September 4, at 10.30 a.m., General Meeting. Papers to be read and discussed:—Mr. M. A. Grossman and Mr. E. C. Bain: "On the Nature of High-Speed Steel"; Mr. L. Aitchison and Mr. G. R. Woodvine: "Changes of Volume of Steels during Heat Treatment"; Mr. C. A. Edwards: "Pickling: The Action of Acid Solutions on Mild Steel, and the diffusion of Hydrogen through the Metal"; Mr. F. C. Thompson and Mr. E. W. Millington: "The Effect of Free Surfaces on the Plastic Deformation of Certain Metals." Friday, September 5, at 10.30 a.m., "Ferrous Alloys Research." Part I.—Introductory, by Dr. Water Rosenhain. Part II.—"Iron and Oxygen," by Mr. Fred. S. Tritton and Dr. D. Hanson. Part III.—"The Estimation of Oxygen in Pure Iron," by Mr. T. E. Rooney. Dr. W. Rosenhain: "Present Position of the Theories of the Hardening of Steel." Mr. Axel Hultgren: "Improvements in the Brinell Test on Hardened Steel, including a New Method of Producing Hard Steel Balls." Mr. C. Benedicks and Mr. V. Christiansen: "Investigations on the Herbert Pendulum Hardness Tester." Mr. E. D. Campbell and Mr. G. W. Whitney: "The Effect of Changes in Total Carbon and in the Condition of Carbides on the Specific Resistance and on Some Magnetic Properties of Steel." Mr. J. Newton Friend and Mr. W. E. Thornycroft: "Examination of Iron from Konarak."

TENDER.—The Ministry of Public Works at Buenos Aires, Argentina, are calling for tenders for the supply and delivery of 25 steam travelling cranes and one stationary electric crane. Tenders must be presented by 3 p.m. on October 27 next, by local representatives only. Further particulars may be obtained on application to the Department of Overseas Trade, 35, Old Queen-street, London, S.W.1, quoting reference A.X.1255.

BRADFORD TECHNICAL COLLEGE.—The prospectus of the college for the session 1924–25 has now been issued and contains full details regarding evening and day courses in textile technology, chemistry, dyeing, and mechanical, civil and electrical engineering. Courses in architecture, building, biology, pharmacy, mathematics, and physics are to be given, instruction in the latter subjects extending to the standard required for the London B.Sc. degree.

MESSRS. WILLIAM JESSOP AND SONS, LIMITED.—For many years this firm has been exporting steel made at their works in Sheffield to America and Canada, and in addition, until recently, has owned all the stock in a company called the Jessop Steel Company, having a factory at Washington, Pennsylvania, which company has been making and selling some classes of steel in America and Canada. The demand for Jessop's genuine Sheffield steel is so distinct from the demand for the American domestic product that Messrs. Wm. Jessop and Sons, Limited, have thought fit to sell their holding, consisting of all the stock in the Jessop Steel Company of Washington. This sale, however, by no means covers all, or even the principal part, of the firm's interests in America, in spite of rumours circulated to that effect.

THE LATE SIR A. W. SMITHERS.—The death of Sir Alfred Waldron Smithers, which, we regret to state, occurred on the 22nd inst., removes a figure well known in city circles, more particularly in connection with the financing and direction of railways. Sir Alfred was deputy-chairman of the South Eastern and Chatham Railway for some years previous to the time of its absorption into the Southern Railway Group. It was, however, as head of the Grand Trunk Railway in Canada that he was most prominently brought before the public. His connection with this company dates back to 1856, in which year he made his first tour of Canada. In turn he became vice-chairman and finally chairman in 1909, devoting the best years of his life to the development of Canadian transport, in which he so materially assisted. Sir Alfred Smithers was in his 75th year.

EXPLOSIVES IN MINING OPERATIONS.—In Technical Paper 358, just issued by the Department of the Interior, through the Bureau of Mines, statistics are presented relative to the amount of explosives used in mining operations in Great Britain and British Columbia for a period of several years. In Great Britain, where coal-mining operations are generally conducted on the longwall system, explosives are not required in such large quantities as in the United States. During the five years ended 1915, the consumption of explosives in Great Britain in mines under the Coal Mines Act, was 79 lb. per thousand net tons of coal; in the five years ended 1920, the consumption had increased to 95 lb. per thousand tons. The figures for British Columbia do not relate to years prior to 1915, but in that year an average of 149 lb. of explosives was used per thousand net tons of coal mined in the Province; in 1922, the average was 224 lb. During the last two years covered by the table, all shot firing at coal mines in British Columbia has been by electricity.

ELECTRICALLY-OPERATED NAVVY FOR THE MORWELL POWER SCHEME.

CONSTRUCTED BY MESSRS. RUSTON AND HORNSBY, LIMITED, ENGINEERS, LINCOLN.

(*For Description, see Page* 299.)

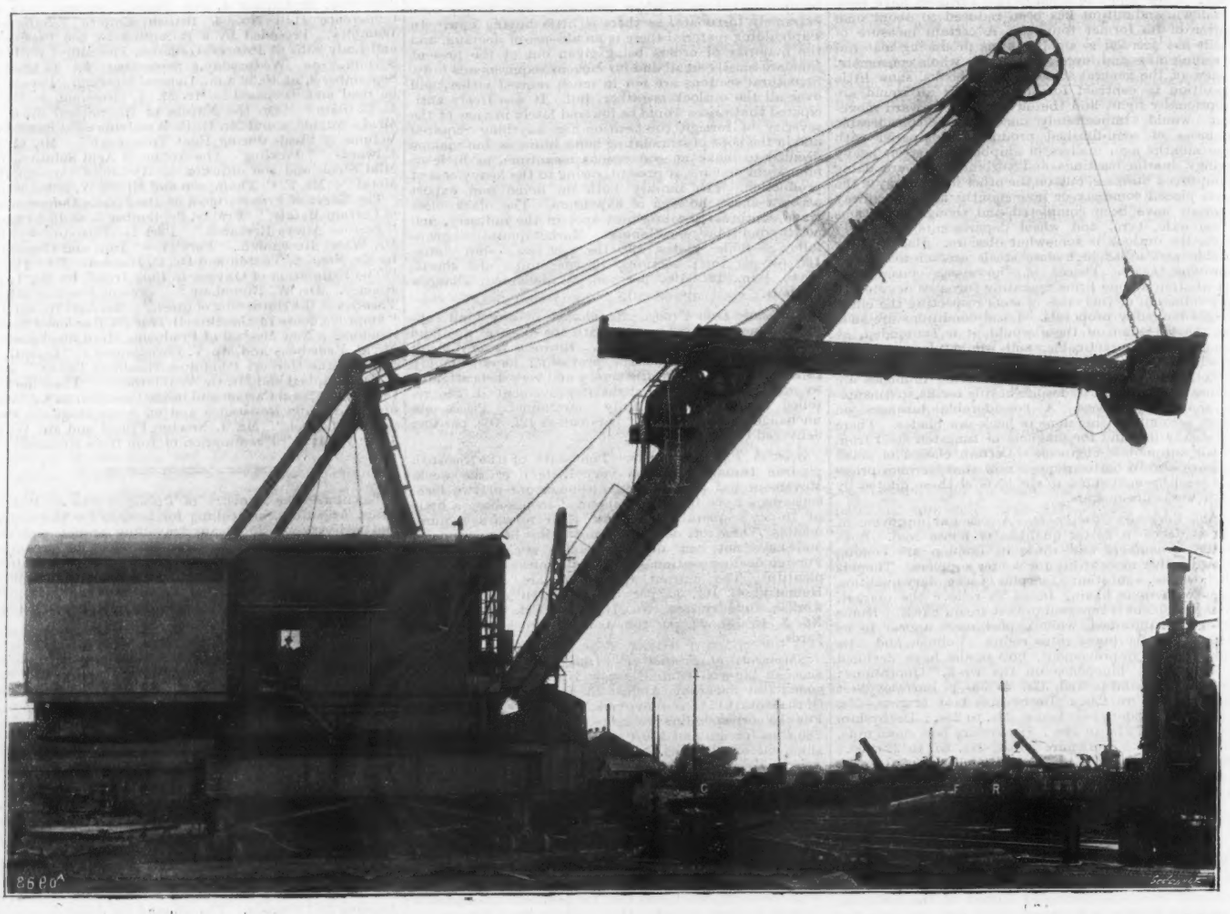


Fig. 1. Completed Machine Ready for Testing at Makers' Works.

Important Railway and Road Bridge Projects in Denmark.—Whilst several works planned by the Danish State railways have been temporarily postponed on account of the less favourable financial position, the scheme for constructing a railway bridge across the Little Belt, connecting the island of Fuhnen with Jutland, is being energetically proceeded with. The engineers of the State railways are busy preparing the plans in detail, and in due course tenders will be invited on the basis of these plans. According to the present intention, the tenders will be invited under two different conditions, partly on the basis of the detailed plans prepared by the staff of the State railway department and partly as "free tender," subject to certain conditions, but otherwise it will be left to the competing concerns to submit their own detailed projects. It is thought that this method may produce lower tenders. In case of free tenders, a commission will be appointed to choose between the tenders received. A grant of 50,000 kr. has been voted for work and prizes in connection with the projected high-level bridge across the Copenhagen harbour and competitive designs are about to be invited. It is intended to connect Copenhagen with that part of the city which is called Christianshavn, which is located in the island of Amager, separated from Copenhagen by the harbour. The two existing bridges, Knippelsbro and Lanzebro,* both of which are modern structures and have been fully described in Engineering, are inadequate to withstand the increased traffic and other means of communication have been under consideration for some time. The new bridge is planned to proceed from Dybbölsgade, to cross over the area of the goods station and the harbour to the island of Amager, and to terminate at Artillerivej. The bridge is to be 21·5 m. above ordinary water level, 20 m. wide, and is to be capable of carrying all kinds of road traffic, but will not have a railway track. A large and thoroughly representative committee has been appointed to consider the proposals and plans to be submitted. This committee will not include any foreigners.

* See Engineering, vol. xci, page 402.

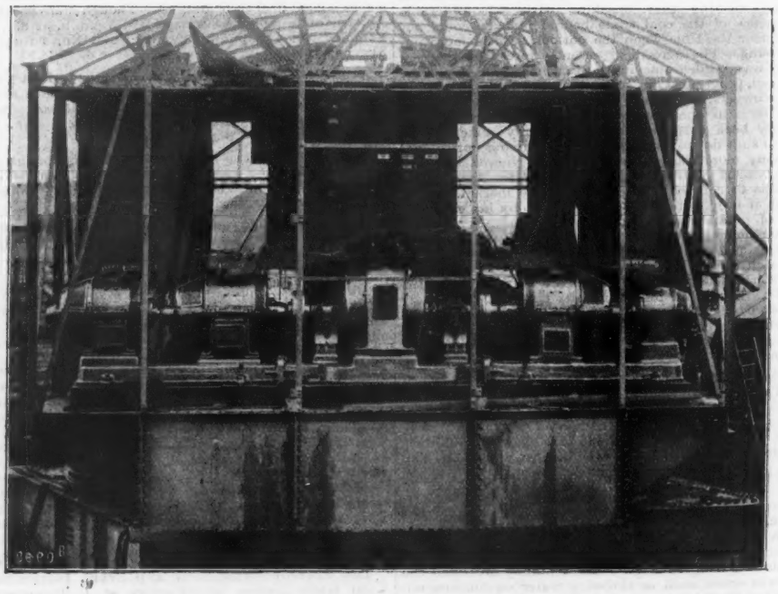


Fig. 2. Motor-generator Set in Machinery Cabin.

42-TON HOPPER WAGON FOR THE BENGAL-NAGPUR RAILWAY; BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY THE MIDLAND RAILWAY CARRIAGE AND WAGON COMPANY, LIMITED, BIRMINGHAM.

(For Description, see Page 279.)

Fig. 125.

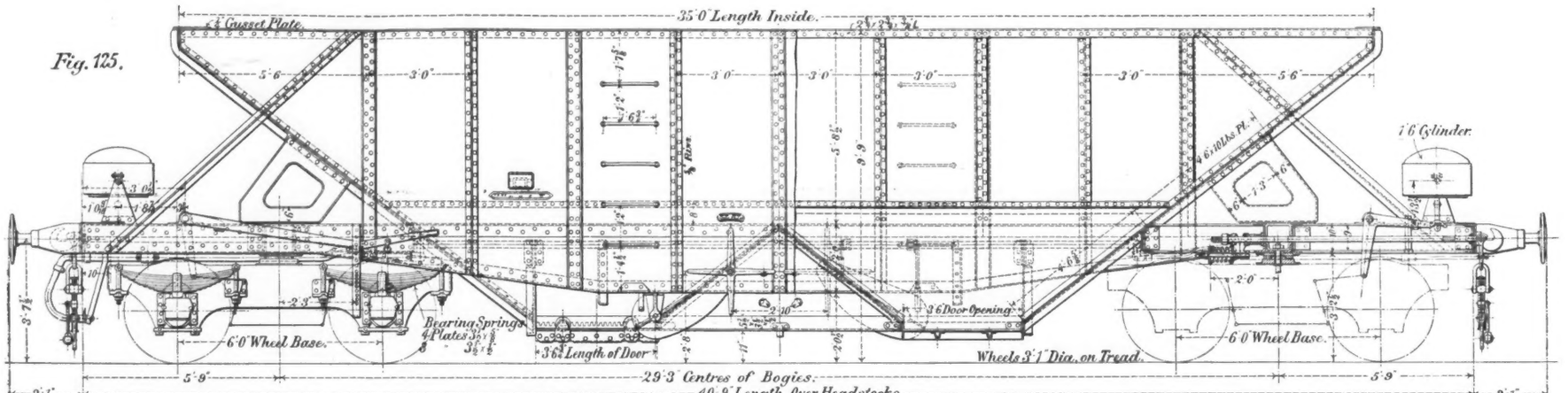


Fig. 126.

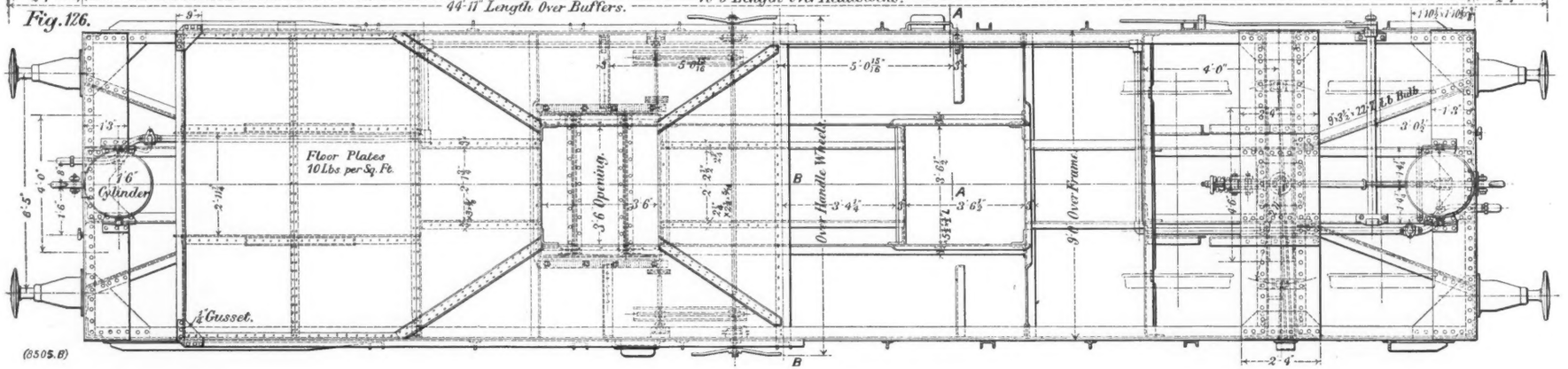


Fig. 127. SECTION A.A. SECTION B.B.

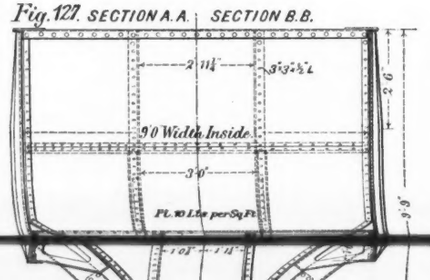
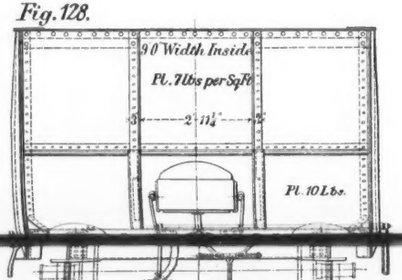


Fig. 128.



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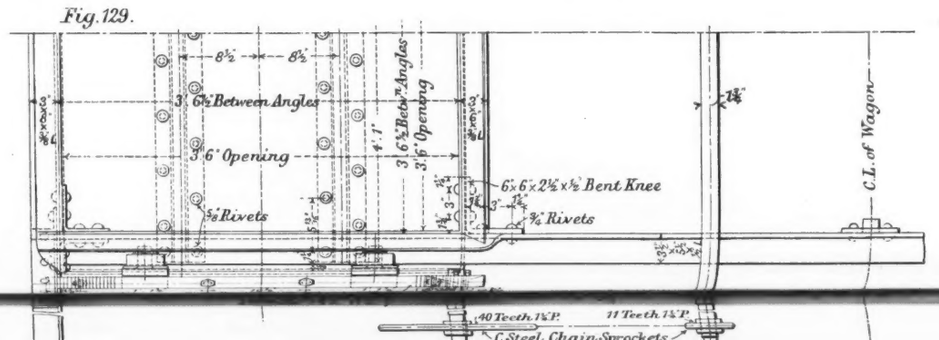


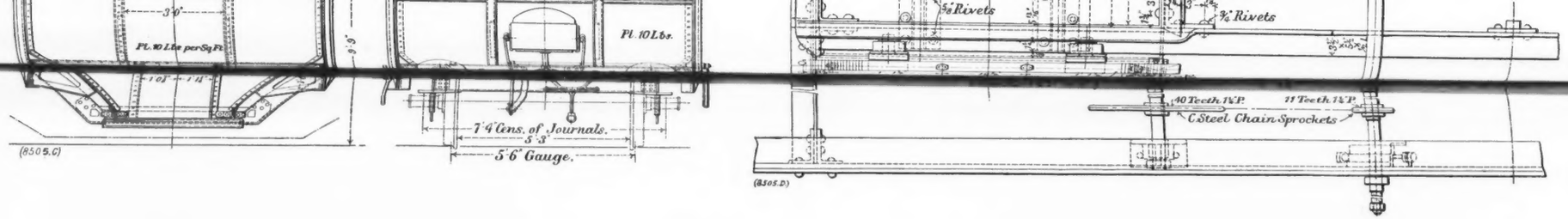
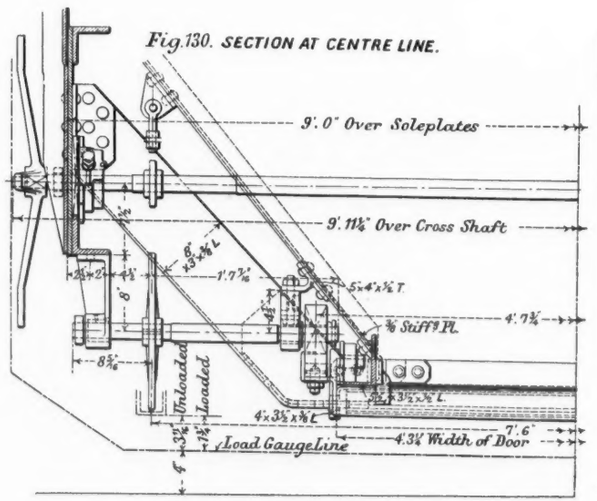


Fig. 130. SECTION AT CENTRE LINE.



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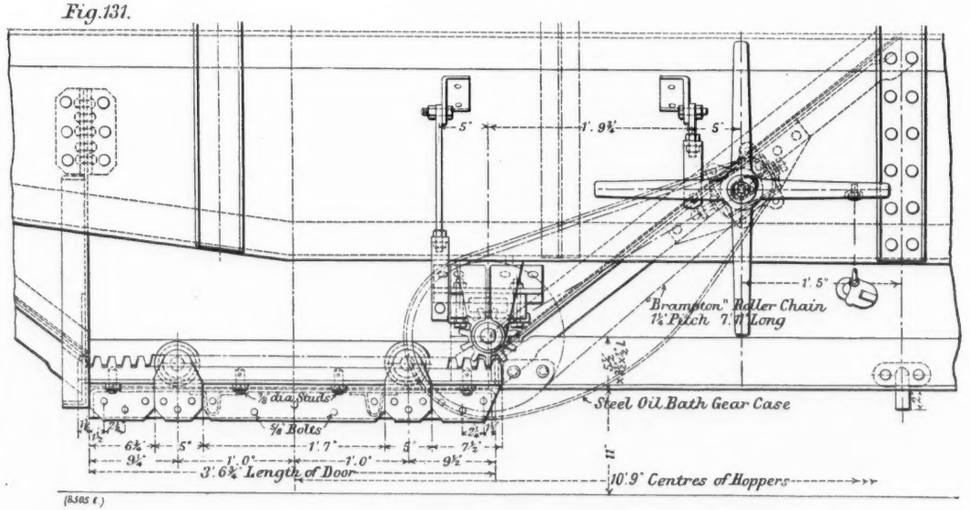
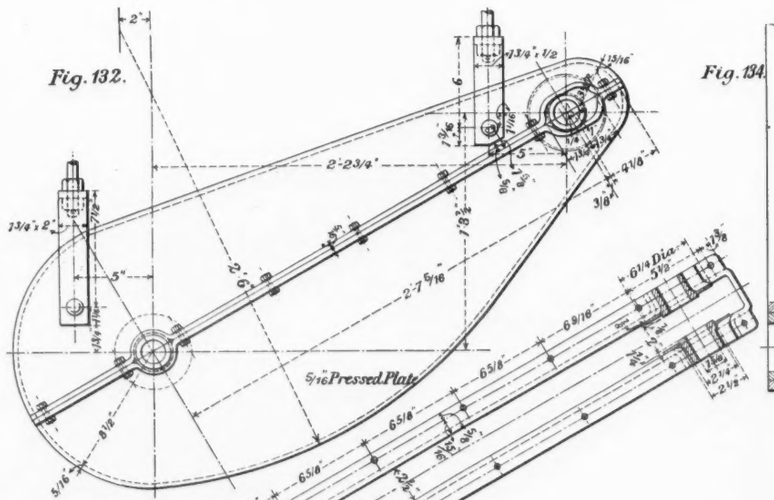


Fig. 132.



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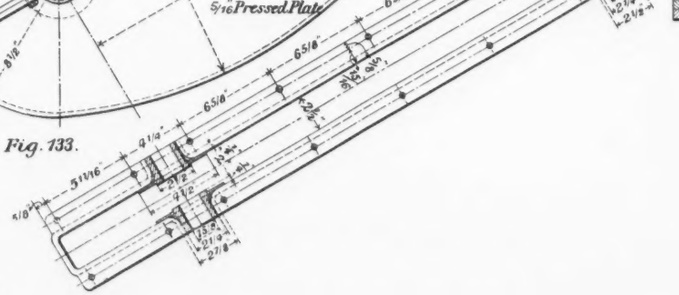

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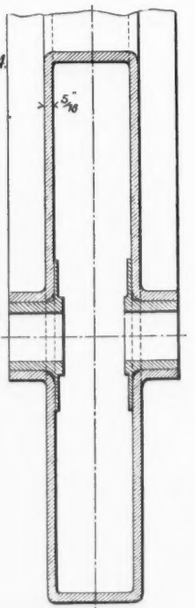

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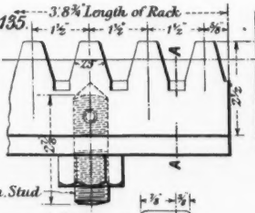

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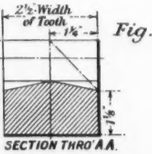

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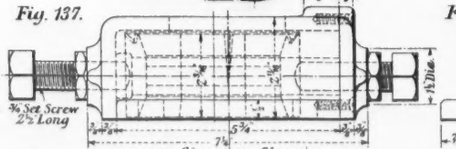
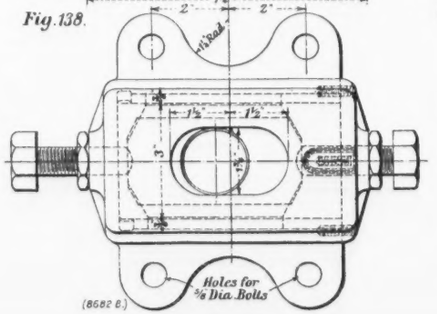


Fig. 138.



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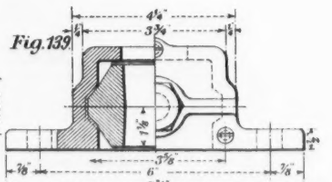
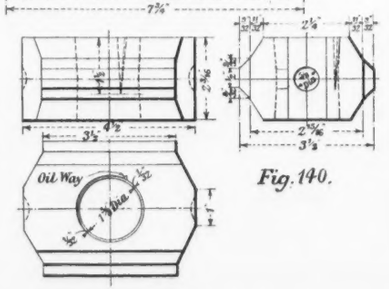


Fig. 140.



ENGINEERING.

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Two-Page Plate.—*42-TON HOPPER WAGON FOR THE BENGAL-NAGPUR RAILWAY; BRITISH EMPIRE EXHIBITION.*

ENGINEERING.

FRIDAY, AUGUST 29, 1924.

THE LATEST COAL PROGRAMME.

A FAVOURITE occupation of young men is to discuss how the universe was made and what modifications they would introduce if they had to make it again. In maturer life this disposition sometimes takes the form of elaborate designs for re-making some branch of industry. No industry has suffered more constantly from the interference of amateur reconstructionists than that of coal mining. It may be that such attempts have arisen from some ulterior influence, and have a wider scope than that industry. But whatever may be their origin or their real purpose, they usually take the form of prescriptions that extend far beyond the knowledge on which they could safely be based.

The latest programme for reconstructing coal mining, and incidentally the mining of iron ore, fire clay, ganister, and similar deposits, has been put forward by Mr. Lloyd George in the form of a report from a Committee over which he has presided. The purpose of this body was to find out what was really wrong with the coal industry, and to formulate proposals for reform that might be carried into effect by general consent and with the minimum of controversy and delay. It was not till March of this year that invitations were sent out to a number of persons to join it, and its report was ready for publication at the beginning of July. Of the composition of the Committee, which is said to be representative of industry and public life, the only specific statement that is made is that it included Liberal Members of Parliament, and that its recommendations are approved, not only by Mr. Lloyd George but by Mr. Asquith. No names are given of the persons who composed the Committee or gave evidence before it, nor any technical details of the evidence they gave. "Special enquiries" are said to have been made into what has been done in France and Germany since the War; but the tenor of the report seems to show that the enquiries both here and abroad were more general than special. To this report (Coal and Power: The Report of an Enquiry presided over by the Right Hon. David Lloyd George, O.M., M.P., Hodder and Stoughton, 1*s.* net.), the Mining Association have now issued an official reply: (Politics and Coal: An answer to "Coal and Power." Mining Association of Great Britain), in which it stigmatises the proposals as unjust, unpractical and mischievous, a recrudescence of proposals made to the Sankey Commission and now put forward as a political rather than an industrial measure.

In substance, the proposals may be shortly described. Attributing the main trouble in the industry to the existence of mine owners to whom colliery owners have to pay royalty, the Committee would have the State purchase the entire mineral rights of the present mine owners, and grant leases to suitable persons or bodies upon such terms as they may think likely to improve the efficiency with which the coal deposits are worked, the prosperity of the industry, and the welfare and amenities of the workers. This transaction is to be carried out and the leases granted on the State's behalf by a small body of Royalty Commissioners, who are to be neither politicians nor attached to a Government department. The initial operation is estimated to cost some £70,000,000, payable in bonds secured on the profits of the industry; and out of their purchase price the expropriated owners are to contribute £7,000,000 as a capital addition to the Welfare levy of £1,000,000 per annum, which is now proposed not to expire at the end of its six years, but to be made permanent. The properties to be thus acquired are those that are actually being worked or that are known to contain deposits of sufficient value to make their working desirable. By an ingenious device, the owners of properties believed to be of the latter class, are allowed five years within which to notify their estimate of their present value, which thereafter will become the basis on which the estate will be assessed for taxation if and so long as the State does not buy it, but at the State's option may be replaced by a valuation in the event of purchase. Any minerals on estates in respect of which no such valuation is lodged, or on which the existence of minerals is unsuspected, will become the property of the State without compensation. The committee is likewise concerned to secure better utilisation of coal; and in order to hasten this, and incidentally to provide immediate relief to unemployment, it proposes to give the Electricity Commissioners compulsory powers for constructing trunk lines and other works to replace existing electrical generating stations by "super-power stations."

The principal purpose of the provisions for acquiring mineral rights is to enable existing and future collieries to work to better advantage by mutual co-ordination, and as fast as possible to substitute new mines with more profitable deposits for old ones. To those who are familiar with the difficulties involved in co-operation between mines—difficulties not necessarily insuperable, but requiring for their solution a close scrutiny of the individual circumstances of the mines in question—the period of the Committee's enquiry seems too short to have justified so sweeping a conclusion as that which they have reached. It seems difficult to imagine how, during the Parliamentary session, a body of members could have found adequate time to investigate the extent to which co-operation such as is desired is unlikely to be attained under the existing system, or the nature and magnitude of the difficulties that the Royalty Commissioners would have to face in defining the extent to which such co-operation should be enforced in the future. The extremely general terms of the report make it absolutely impossible to form an opinion as to how far the Committee considered such questions, or on what evidence they were led to expect a better result under the control of Royalty Commissioners, who were to be subject personally to actions at law in the event of their exceeding their authority, than from the spontaneous action of the owners themselves. If they made due inquiry, they must have been aware that spontaneous co-operation had already been fruitful of results, as, for example, in the form of central pumping stations, and that much more might be expected in the same direction if the mine owners had a greater security from disturbance than the circumstances of the industry during this century have ever allowed.

The report lays hardly less stress on the duty that the State owes to the miners. According to its account, the conditions of life to which their employment condemns them give them a unique claim on the assistance of the other parties to the

industry or even of the State itself; and while acknowledging that the industry must be made to pay before it can discharge this duty permanently, and that the responsibility for making it pay must be left strictly on the owners, the report urges that the working miners, who are not to share responsibility, must be given an effective voice in determining the policy to be adopted by the owners.

The facts, however, are far from making out any such superior claim on the part of the miners as these proposals suggest. The recent regulation of the shares of owners and miners in the profits of the industry has given the miners definite protection against being deprived of the major share of such profits as the mines may earn. Their actual earnings in real wages, *i.e.*, corrected for increase in the cost of living—are under 2 per cent. less than they were before the war, while the hours for which they work are 12½ per cent. less; and even with this increase in their leisure, many of them absent themselves frequently from the mines for the mere reason that they are not disposed to work. It may be thought that this is due to the arduous nature of their occupation and the strain it imposes on their health and strength. Among those who profess to speak on behalf of the miners no opportunity has, indeed, been lost of suggesting that the occupation and the conditions in which it is pursued levy a far higher tax on the vital capacity of the worker than ordinary occupations. As a fact, however, it turns out that, although this was perfectly true 70 years ago, for many years past it has been the exact reverse of the truth.

Dr. J. S. Haldane, whose competence and impartiality are beyond suspicion, has pointed out that in the figures for 1910–12 the death-rate of employed and retired coal miners was substantially below that of all employed and retired males, and except for the age group from 15 to 25, was lower than in every decade of life. In his judgment, indeed, the figures show that the life of a collier under present conditions is an exceptionally healthy one, and that on balance the healthiness of the conditions in which he lives more than compensate for the extra risk from accident; deaths among colliers from causes other than accident are "very considerably below the average for other occupations." So far as concerns accidents, which at present are about 0·4 per thousand in excess of the rate in the general population, more than half those that occur in coal mines are due to falls of roof, which to a large extent arise through the neglect of precautions by the miners themselves. The death-rate from explosions is now only one-twentieth of what it was fifty years ago. Such results give little evidence of indifference or incapacity on the part of existing owners in promoting research into means of increasing the safety of their workings, or of slowness in putting the results into practice. The records of the several bodies that have been working on questions relating to safety in mines give, on the contrary, the most direct evidence of the constant enthusiasm with which attempts to minimise these dangers have been pursued. This continuous zeal has made and kept British coal mines the safest in the world, as admittedly they are; and the suggestion that mine owners neglect measures of safety for the sake of dividends is contradicted by the record of what they have done no less than by statistics.

The Committee's proposals find as little support in economical considerations. If mining royalties were simply extinguished without compensation, the cost of coal would be relieved by about 6*d.* a ton, against a rise of price at the pit's mouth of over 10*s.* a ton since the war, and a balance to the colliery owner varying from a profit of 2*s.* 9*d.* a ton to a loss of 1*s.* 7*d.* No juggling with the owner's 6*d.* can therefore have a serious direct effect on the handicap of dear coal under which our manufacturing industries suffer, and so far as the particulars given permit a judgment to be formed, the proposed powers of both Royalty Commissioners and Electricity Commissioners, if they were operative at all, would add profoundly to the present grave economic dangers of the country. The proposals are of the same order as many initiated during the war. The practice of war is distinguished from that of peace in being absolutely indifferent to cost when a military need is in question, and in no way was this difference shown more conspicuously during the great war than in the recklessness with which economic decisions were taken so soon as it was believed that they would supply what was required, without waiting to inquire whether more deliberate means would yield the same result at a less expense, or even whether it was certain that the immediate course would be effective. This recklessness was doubtless often justified in war; but the proposals of Mr. Lloyd George's Committee must be condemned because they show the same recklessness in critical times of peace.

The memory of engineers is not so short that it has forgotten the effect of Government control on the development of the electrical industry, our backwardness in which the Committee deplores, and of the motor-car industry. To take out of the hands of colliery owners and managers the decision as to when a deposit is or is not so worked out that it can be prudently abandoned for ever, when neighbouring properties could profit by conjoint works, and the many other intricate questions that can be answered only by intimate knowledge and trained experience would be to cripple the action of those who under any system must bear the responsibility for the mine's success. To put down super-stations at the pit's mouth when the manner in which the coal should be burnt is still uncertain—only a week or two ago the scope of the investigations into alternative means had to be hurriedly enlarged—would be a wild and unjustifiable gamble, with long odds against success. Least of all can such proposals as those of the Committee be applied prudently when they bear the mark of an endeavour to compromise with the avowed enemies of our economic state. Again and again one party professing to be in the miners' camp has avowed candidly that its purpose is so to bleed industry that capital will be compelled to retire from it, and leave it to be administered on communist or socialist lines. How many of the 43 Members of Parliament whom the Miners' Federation maintains in the House to promote what the Federation regards as the interests of the miners are intent on this method of dispossessing capitalists is not for us to inquire. We speak solely from the point of view of technical administration, and nothing is clearer than the fact that the scheme embodied in this report does not meet the fundamental difficulties of the operations it recommends. If carried into law it would add gravely to the difficulties of the coal mining industry and those that depend on it.

THE SEVERN POWER SCHEME.

The communication that has been made this week to the press in regard to the Severn power scheme will relieve some natural anxiety that may have been caused by Mr. Snowden's statement on July 30 that the Government had decided to revive the Severn barrage scheme for the purpose of relieving unemployment. It will be remembered that it was then announced that the Government had agreed to spend about 95,000*l.* on a full investigation, which the tenor of the statement seemed to imply would be directed rather to defining the location and design of the intended works than to ascertaining whether in fact any such scheme was practically feasible at all. It is now announced that the investigation has been placed in the hands of the Department of Scientific and Industrial Research, and that before any large works or even the definite determination of the necessary data are undertaken, a preliminary investigation will be made of a more limited scope. It is recognised, in fact, that before the site and design of works for harnessing the tidal power of the Severn can be usefully or even prudently considered, at least two preliminary classes of observation must be made. On the one hand, it must be ascertained whether *prima facie* any suitable site would be available that could carry the vast dam that would be necessary, and on the other hand a considered opinion must be formed as to whether the contemplated works could be carried out consistently with the geological, hydrographical and economic circumstances of the district, assuming that preliminary investigations had shown that safe foundations could be found.

Accordingly, Lord Parmoor, the Lord President of the Privy Council, under which the Research Department operates, has appointed a committee to supervise and direct certain preliminary investigations into "the feasibility of the scheme for using the tidal power of the river Severn for the production of electrical power by the erection of a barrage across the river." The chairman of this committee is Mr. G. S. Albright, whose work both on the Water Power Resources Committee and as chairman of the Nitrogen Fixation Committee will be remembered, Professor A. H. Gibson and Mr. Maurice Wilson on the engineering side, and Mr. G. W. Lamplugh and Dr. J. S. Flett as geologists. This committee, the constitution of which will command general confidence, will receive in the first instance a study by the Geological Survey of the stratigraphical formations in the neighbourhood of the suggested sites, and will have preliminary soundings taken with a view to determining the contour of the river bed at the proposed sites and preliminary measurements of the flow of water at different states of the tide and presumably under different wind conditions. Simultaneously it has been referred to Sir Maurice Fitzmaurice and Sir John Purser Griffith to report generally by the end of the year in the light of the above data whether a barrage can be constructed, assuming that safe foundations exist.

This scheme of work will obviously not cost anything like the sum contemplated for the entire preliminary investigations to which Mr. Snowden referred. It represents the least that can be done to warrant further steps being taken, and until the results of these inquiries are known, any further expenditure would be merely speculative. In the event of the inquiry showing that safe foundations can be obtained and that the scheme is in fact feasible as an engineering proposition, still further investigations will then become necessary before any definite opinion can be formed as to whether it could be translated into actual practice in the circumstances in which it would have to be applied. Only when these questions have been answered in the affirmative could any steps be taken prudently that would have an appreciable effect on the present condition of industrial employment.

From the suggestion that the scheme should be revived as a measure for the relief of unemployment, it seems indeed as if the Government had under-estimated the magnitude and complexity of the project, and the step-by-step process of investigation that the Research Department is adopting is not only required by ordinary prudence but may prevent the waste of large sums of public money. Mr. Snowden did not exaggerate when he stated that, if the scheme were carried to a successful issue, it would be one of the most difficult engineering feats in the history of the world. As such its accomplishment would be gratifying in all ways; but the size and difficulty of the proposition do undoubtedly demand correspondingly great care in making sure that it is sound, for the consequences of failure would be proportionately disastrous. No interference with the natural flow of rivers is possible without causing indirect consequences, which in the Severn scheme may be expected to be more than usually redoubtable. To obtain the contemplated power, the barrage must be constructed across a wide stretch of the estuary, and the district affected is already so lightly developed that the possible consequences have to be followed in many directions.

Before any definite works can be contemplated it will be necessary, for example, to make a careful study, not merely of the natural reservoir accommodation that is available, but also of the processes of silting that go on in the estuary. Apart, again, from the necessary difficulties of design and construction, provision would have to be made in the barrage to allow the passage of ships to ports such as Sharpness, which presumably must be situated above it. The trade of these ports is done at present by vessels of as much as from 2,000 to 3,000 tons, and it would be necessary for these to pass up to their destination during the process of constructing the barrage as well as afterwards. The Great Western Railway, too, has reason to regard the construction of a bridge over the Severn as necessary to complete its traffic

arrangements in the district, and constructional questions would arise as to the relation between such a bridge and the barrage.

These are merely examples of technical questions of fundamental importance that would have to be answered before the scheme could be safely initiated. There are, however, in parallel with these technical questions a number of economical aspects that must be considered when determining whether, if the scheme were practicable as an engineering work, it could pay economically. The district, for example, is not itself a great manufacturing centre, and sufficient inquiry would have to be made to ascertain whether the farming uses (which in New Zealand, for example, have been found to provide a very useful load for hydro-electric stations) or other local industries would be able to take a sufficient quantity of current; or whether the cost of transmission to the nearest great manufacturing centres would leave the current sufficiently cheap to assure the desired market. Even before such an enquiry, indeed, it would be necessary to estimate with some precision the cost at which current could be generated, as compared with what could be done by means of coal, of which such important deposits are available in the immediate neighbourhood.

These observations are not in any sense a discussion of the technical and economical questions that arise on the Severn scheme, nor do they imply any opinion as to its engineering and economic practicability. No such opinion can be formed without the information that the Research Board's Committee is seeking, and the questions suggested above as requiring to be answered before the scheme can be adopted safely are merely illustrations of how great and far-reaching the inquiries must be to justify the works being undertaken. The result of such inquiries may be wholly satisfactory, and the resources of the country be enriched ultimately by a source of power as yet untapped, and an engineering work of which the like does not yet exist. A cultivated imagination can obtain such results easily in the study, and with the support of public funds can proceed to considerable lengths in the enthusiastic endeavour to realise them. In proportion, however, to their size and to the extent of the benefits that they might yield if successful, is the waste or even disaster that would arise from their failure, and the indispensable necessity for investigation at each stage. Any works less suitable to be undertaken summarily in relief of unemployment it would be difficult to conceive; and if, as Mr. Snowden's statement in the House of Commons seemed to imply, the Government ever contemplated proceeding with the scheme on these lines, or even embarking forthwith on investigations involving the large sum that he mentioned, its second thoughts have saved it from a grave imprudence. They illustrate, too, not for the first time, the value of the Research Department's function in bringing to bear on a problem of the first magnitude in industrial science the co-ordinated judgment of men of the first eminence in its practice, whose individual work is done outside the grooves of a Government Department.

INDUSTRIAL CINEMATOGRAPHY.

THE adage that time and tide wait for no man has been in part falsified by the evolution of the cinematograph, which provides a method by which actual time intervals can be slowed down indefinitely. Thus a sequence of rapidly-succeeding operations or processes can now be examined at leisure. A striking illustration of the utility of the cinema camera for effecting such analyses was given by Professor C. E. Larard at the Dundee meeting of the British Association in 1912. He showed a complete cinematograph record of the rupture of a bar in torsion, every detail of the process of fracture being shown on a highly-magnified scale. Professor Larard's aims were scientific, but there have been cases in which the camera or the stroboscope has been used to control industrial processes, particularly in the textile trades, where certain cases of repeated thread breakage were in this way completely elucidated. Many manufacturers in the Birmingham area have, it appears, been anxious to apply similar methods to certain of their own problems, but it has hitherto proved extremely difficult to provide satisfactory lighting. This led to the matter being taken up by the Industrial Research Laboratory of the City of Birmingham Gas Department. This laboratory, which was inaugurated some six years ago, has proved to fill a distinct want, and as a result it has, under the direction of Dr. C. M. Walter, the engineer-in-charge, grown into a completely-equipped public testing laboratory, provided with testing machines, of which the largest has a capacity of 100 tons, with an experimental foundry, and with the furnaces and other gear needed for the study of methods of heat treatment. Metallographic work is also undertaken. The laboratory has, moreover, been permitted by the Board of Trade to register its own test mark. Test bars thus stamped are recognised as authoritative by the Air Ministry and other important purchasing organisations. That this important testing department should have developed out of a research laboratory established by the Birmingham gas undertaking, is perhaps less remarkable than it appears at first sight, since town gas is used on an enormous scale in Birmingham for metallurgical furnaces of all kinds. One firm alone takes all the gas an 8-in. main is able to supply. A good deal of the work of the research laboratory has moreover consisted in showing manufacturers how gas furnaces should be designed and operated. The earlier types were very badly insulated and correspondingly wasteful of gas.

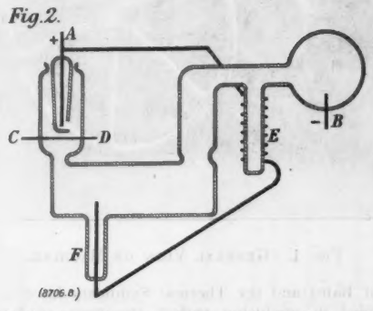
It was to these laboratories, therefore, that the manufacturers desirous of using the cinematograph turned for assistance in the matter of securing more satisfactory lighting. Methods based on the use of arc lamps or ½-watt wire lamps are stated to have taken considerable current and given comparatively poor results. The laboratory turned, therefore, to the mercury lamp, of which the pattern due to Messrs. Kelvin Bottomley & Baird, Limited, of 299, Hither Green-lane, London, S.E.13, working in conjunction with the Thermal Syndicate, Limited, has been found most effective, and a demonstration of its utility in the taking of cinema views in badly-lighted interiors was given at the laboratories on Wednesday last.

The lamp in question has a quartz body. It is self-starting, and the mercury vapour is at atmospheric pressure and not at a high vacuum, as in the original mercury lamps first inroduced nearly a generation ago. The plan of working at atmospheric pressure has, moreover, not merely its obvious mechanical advantages, but a comparison of the spectra taken with the mercury in a high vacuum, and at atmospheric pressure shows that the latter is materially better as a source of actinic rays.

A photograph of the lamp in question is reproduced in Fig. 1, but its construction and operation will be more easily understood from the diagrammatic view, Fig. 2, in which, however, certain component parts have for the sake of greater clearness been displaced from their actual positions.

FIG. 1.

Fig. 2.



The diagram represents the lamp out of action. The whole of the tubing below and beyond the level C D is filled with mercury, and into this at B projects the negative electrode, which is a tungsten wire. In the condition represented by the diagram, the positive electrode A stands clear of the mercury and hence no current can pass from A to B through the mercury, but there is, as will be seen, an alternative path from A round a heating coil placed on the branch E and into the mercury at the branch F, from whence the current proceeds through the mercury to the negative electrode at B.

Mercury vapour generated in the branch E by the heating coil passes into the main tube, which is somewhat constricted at the point where the branch E joins on. This vapour causes the mass of mercury to break in two at this constriction. The portion on the left is forced back by the mercury vapour, and ultimately raises the level CD up to the electrode at A. The current then passes through the tube, forming a mercury arc between the two portions into which the liquid has been separated as described. The formation of this arc shortcircuits the heating coil at E, which drops, therefore, automatically out of action. Should, however, the current be interrupted, either intentionally or accidentally, and the arc broken, the heating coil will, on the current being turned on again, start up equally automatically and restore the light. The lamps are made for voltages as low as 85, but those used at the demonstration on Wednesday were run on a 440 volt circuit.

It is impossible to use the term candle power in

MULTI-SPINDLE BORING AND TENONING MACHINE.

CONSTRUCTED BY MESSRS. THOMAS ROBINSON AND SONS, LIMITED, ENGINEERS, ROCHDALE.

(*For Description, see opposite page.*)

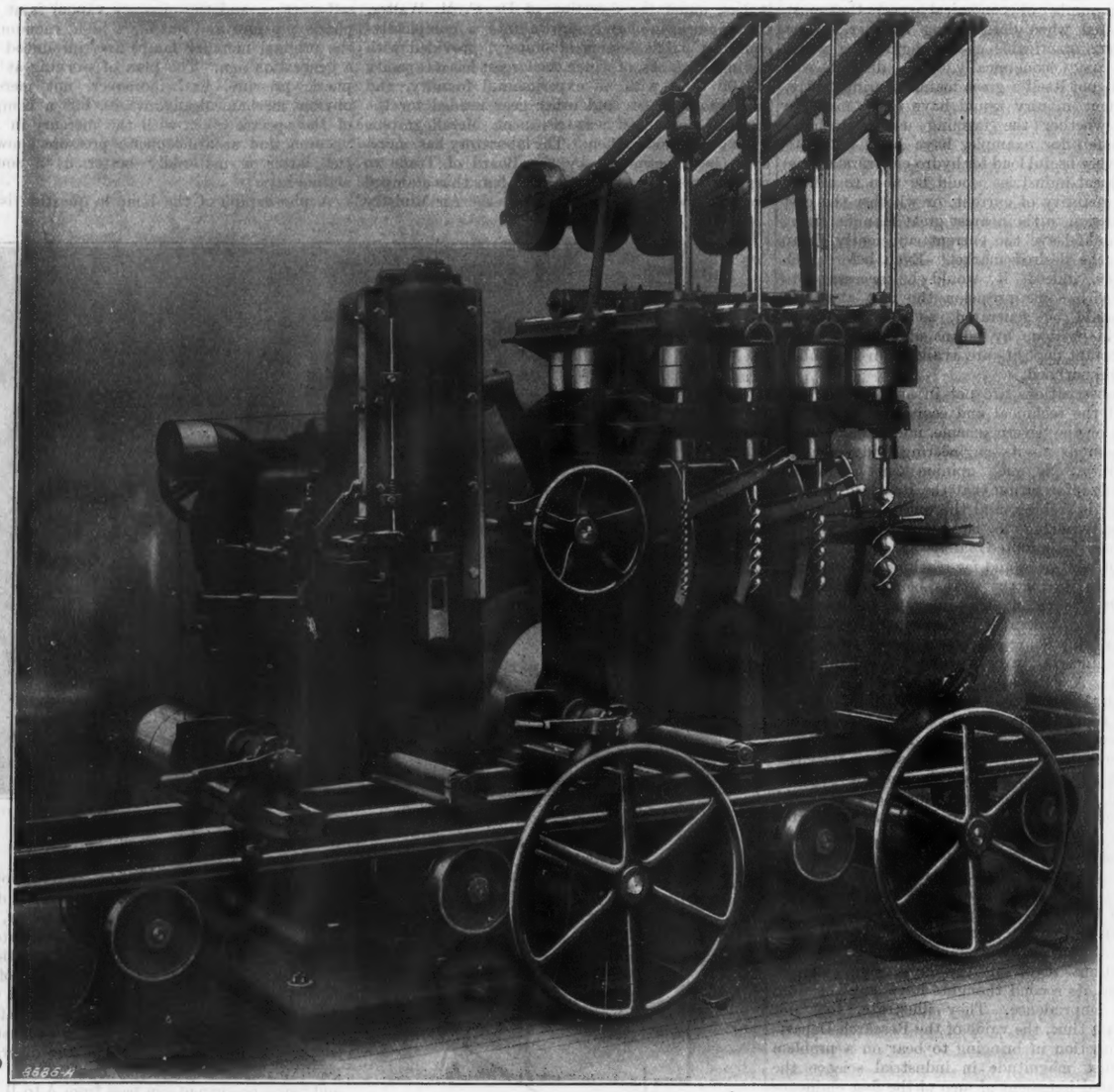


Fig. 1. General View of Machine.

connection with these lamps, since the most important part of the spectrum lies in the ultra violet, far outside of the visible region. In fact, the visible spectrum only covers about one-third of the total range of wave-length obtained.

These ultra violet rays have, as is well known, the property of killing bacteria, and hence the lamps can be used for the sterilisation of water. They are also used for taking micrographs of bacteria, the short ultra violet rays bringing out clearly details much too fine to be obtained with the relatively long waves constituting the visible spectrum. The rays have, moreover, the property of rendering certain bacteria fluorescent, so that they become visible, but to get the best results it is necessary to employ quartz lenses. These have hitherto been made of rock crystal, but, as is well known, this is not an isotropic body, but has different optical properties in different directions, and care must therefore be taken to ensure that the optic axis of the crystal coincides with that of the lens cut from it. Within the last few months, however, Messrs. Kelvin, Bottomley and Baird and the Thermal Syndicate have succeeded in producing perfect specimens of fused silica. These are free from both bubbles and striæ, and in every way comparable to the best optical glass. The largest lenses yet made of this beautiful new material are $2\frac{1}{2}$ in. in diameter, but it is hoped to exceed this limit as further experience is gained.

In view of the opacity of glass to ultra violet rays, this material should not be used for microscope cover slips, and these are therefore now being made of the improved fused silica. The cover slips in question are perfectly flat and parallel and but $\frac{1}{200}$ in. in thickness.

STRESS MEASUREMENTS ON WESTMINSTER BRIDGE.

While no anxiety is felt as to the security of Westminster Bridge, the London County Council has considered it advisable to investigate the effect upon it of the heavy self-propelled traffic which it now carries. The consulting engineers for the work were Messrs. Rendel, Palmer and Tritton, 12 and 14, Dartmouth-street, Westminster, S.W.1, and this firm has recently carried out a series of measurements for the detection of any possible movement in the piers and also to ascertain the actual stresses in the material of the arch ribs under various traffic conditions. The bridge is composed of seven metal arch spans of different lengths, the longest, in the centre, having a span of about 121 ft. For the stress measurements, the Fereday-Palmer stress recorder was employed, this instrument, which was illustrated and fully described in our issue of January 30, 1920, on page 138, enabling a continuous photographic record of the stress variations to be obtained on a moving sensitive film.

Some of the shorter bridge spans having been previously investigated, the central span was dealt with on Tuesday last, the 26th instant. Stress measurements were commenced in the early hours of the morning, with no traffic on the bridge, and continued with the traffic

MULTI-SPINDLE BORING AND TENONING MACHINES

CONSTRUCTED BY MESSRS. THOMAS ROBINSON AND SONS, LIMITED, ENGINEERS, ROCHDALE.

Fig. 2.

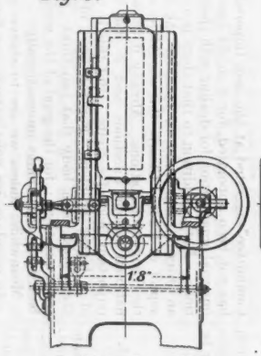


Fig. 3.

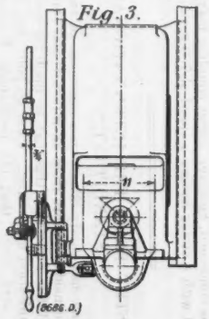


Fig. 4.

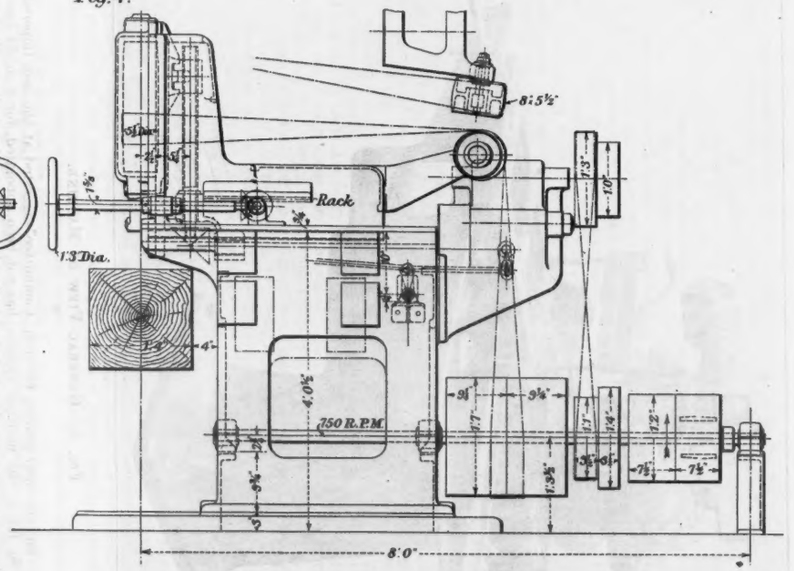
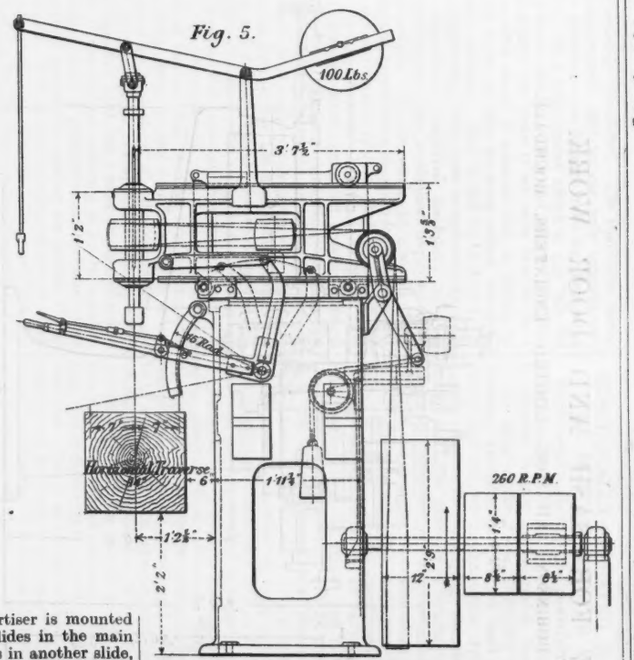


Fig. 5.



gradually increasing to its normal intensity until 3 p.m., when all traffic, both vehicular and pedestrian, was removed for a period of 15 minutes, leaving no external loading on the bridge. Traffic was then resumed and the measurements continued for some time afterwards, so that an analysis of the records should afford complete information as to the effect of varying traffic conditions on the stresses in the structure. No information as to the results obtained is available at the moment, but it is hoped that the report which will be presented to the London County Council in due course will be published later, since both the methods employed in the investigations and the results are matters of considerable interest to engineers.

BORING AND TENONING MACHINES.

AMONG the many machines which will be on view at the Machine Tool and Engineering Exhibition, to be held from September 5 to 27 at Olympia, are a combined vertical hollow-chisel mortising and multiple-spindle boring machine, and a small tenoning machine, which are of particular interest. They are to be shown by Messrs. Thomas Robinson and Sons, Limited, of Rochdale. The first is illustrated in Fig. 1, on page 296, while the details of the design are given in Figs. 2 to 5 above. Figs. 2 to 4 illustrate parts of the firm's type H.K., No. 1 machine, and Fig. 5 the type K.O., No. 1 machine, each of which is manufactured separately. When built into a combined machine, as shown in Fig. 1, a common travelling table joins the two parts together.

Two separate castings comprise the bed of the machine, on one of which is mounted the cast support for the square-hole mortiser and fittings, and on the other the casting carrying the four spindles for the drills and fittings in connection therewith. Suitable for heavy mortising, boring, recessing, and tenoning, such as is constantly required in all classes of railway woodwork construction, the machine is of considerable adaptability. The mortising is performed by a square hollow chisel with a revolving auger inside, the latter removing the core as the chisel is forced down. The mortising head is provided with a cross adjustment, operated by a large handwheel and rack and pinion gear, with a quick-locking device.

The feed of the chisel is controlled by a hand lever, shown at the left side in Fig. 1, which stops, starts, or reverses the feed at any point of the stroke, and which is also shown in Figs. 2 and 3. This lever operates two expanding clutches running in opposite directions and driven by machine-cut speed gearing, all enclosed in an oil-tight bath. These clutches are connected to a quick-thread vertical screw, which actuates the mortising ram. This has been designed with a view to facilitating the boring of several holes of unequal depths which require to be mortised or recessed. The headstock of the mortiser is mounted on steel rollers moving on planed slides in the main pillar, while the mortising ram works in another slide, provided with an adjustment for keeping it in correct alignment with the auger spindle, no matter in what direction wear may take place. The stroke of the arm is variable at the will of the operator and may be conveniently adjusted. The auger spindle revolves in gun-metal bearings and double ball thrust bearings are fitted to take the thrust and support the weight of the spindle. The latter is driven by belt, running over jockey pulleys from a wide drum at the back of the machine, clearly shown in Fig. 1.

It will be seen that the travelling table connecting the two parts of the machine is constructed of two heavy steel girders braced together and carried on eight flanged wheels forming a roller stand, the centre wheel pairs being fixed on the machine base plate. The timber is firmly held in position whilst being worked on by means of the adjustable rollers and quick-acting cramps shown fixed to the table. The table may be operated by handwheel, rack and pinion, or a power traverse by reversing friction wheels (which are not shown in Fig. 1) controlled by a foot lever at the side of the left handwheel. Adjustable longitudinal stops are included for approximately setting the position of the holes to be mortised and bored without previous marking out. Coming to the right side of the machine, that carrying the boring spindles, it will be seen that four are fitted, but two extra canting spindles may be fitted at each side, rotating round a horizontal axis to 30 deg. on each side of the vertical. Adjustable radial stops are provided for holding the spindle at the required degree of cant without the necessity for marking out each hole to be bored. The complete spindle and slide has a vertical adjustment to bring the auger close down to the timber when in this canted position. Self-acting belt tighteners are provided to compensate for the varying length of the driving belt involved by the latter adjustment.

All boring spindles, jockey pulleys and countershafts are mounted on heavy double-row ball bearings. Each boring spindle has an independent quick cross traverse by hand lever and an automatic lock for any position desired. One spindle is fitted with an extra large pulley to provide a slower speed when using large augers. A single belt drives all the spindles from the countershaft at the back of the machine, the belt passing over the jockey pulleys, one of which acts as a tightener. The spindle pulleys can be seen attached to the spindles between the ball bearings. A hand lever, with a clamp, controls the cross travel of the drills, as shown in Fig. 5, while each spindle feed is controlled by a hand rod, a weight tending to counterbalance the pull in each case. When inclined spindles are fitted to the sides of this part of the machine, spring counterbalancing is adopted.

The entire machine can accommodate timber up to 16 in. square and 20 ft. in length. The cross traverse of each spindle is 14 in., boring up to 3 in. in diameter through timber 16 in. thick being possible. The auger shanks are ¾ in. in diameter and 2 in. long, while the driving pulleys are 16 in. in

TENONING MACHINE FOR SASH AND DOOR WORK.

CONSTRUCTED BY MESSRS. THOMAS ROBINSON AND SONS, LIMITED, ENGINEERS, ROCHDALE.

Fig. 6.

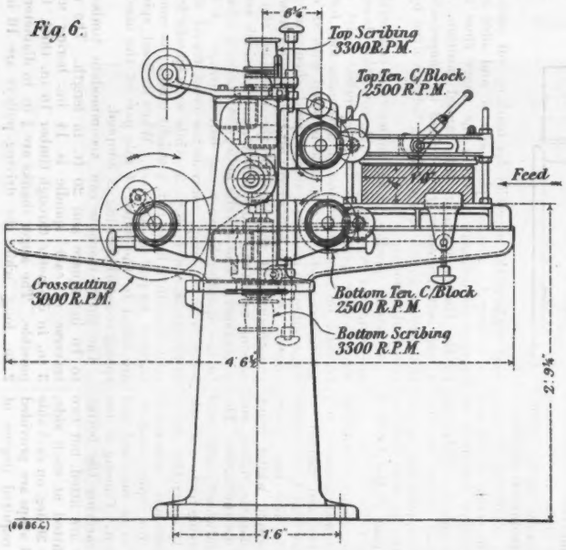
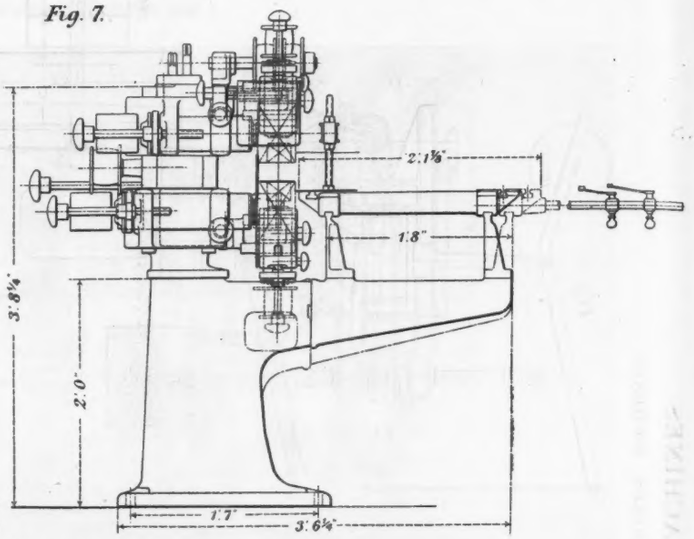


Fig. 7.



diameter by 8¼ in. face and run at 260 revs. The approximate brake horse-power required for operating the machine is 15, while the width of floor space required is 9 ft.

The small tenoning machine, shown in Figs. 6, 7 and 8, has been designed for sash and door work to suit joiners, builders and all kinds of coach-makers. The framework of the machine has mounted upon it two slides over which the movable carriage supporting the wood being worked on travels by means of dust-proof rollers. Adjustable stops are fitted to determine the distance between shoulders in tenoning, and to avoid the necessity for setting out. On this sliding table are mounted two threaded arms, carrying a hand lever cramp. A quick-acting eccentric cramp is also fitted. To the left of the framework the two steel cutter spindles, mounted in double row ball bearings, are apparent, the various knobs and handle at the top controlling the two-way settings. These two spindles are separately driven by separate belts; the main pulley actuates the lower vertical cutter block. In Fig. 8, the machine is shown equipped for single scribing, a 2-in. deep cutter block being mounted, the grooving—or "drunken"—saw, of 7½ in. diameter, on the lower vertical spindle allowing double tenons up to 2½ in. long to be obtained. Guards are provided for the top and bottom tenoning cutters. The 12-in. vertical saw, visible in Fig. 8, is made to advance or retire in a direction perpendicular to its plane by means of a hand knob controlling, by screwed-bar, the shaft on which it is mounted. This shaft is mounted in double-row ball bearings, and the pulley rotating it is of such a breadth as to permit the travelling of the saw. The upper vertical cutter-block spindle is driven by cross-belt from one of the two pulleys shown together at the top of Fig. 8, the saw being independently driven. The maximum size of timber which can be taken by the machine is 12 in. by 4 in., the greatest length of tenon that can be cut being 4 in. The driving pulleys are designed for a speed of 1,000 revs. while a power of 4 b.h.p. is required to drive the machine.

A description of the machine would, however, be incomplete without a reference to the principle adopted for the ball-bearing saw spindle mounting. This mounting forms a complete unit in itself, and is supported from, and level with, the top of the holding bench, thus being readily accessible for inspection. The rear bearing is carried on a steel sleeve or tube through which the saw spindle passes without coming into contact with it. This sleeve projects into and supports the driving pulley, the outer boss of which is keyed on to the end of the saw spindle. Further, the loose pulley, which runs on ball bearings, is carried by a stud quite separate from the saw spindle, so that it is impossible to start the saw should seizing of the loose pulley take place.

Finally, the increasing use of electric motors for workshop driving has led to provision being made for such driving in the case of these machines. In the first type, owing to the low speed of the countershaft, 260 revs., it is necessary to belt or gear-drive from a standard speed motor. Suitable spur gearing for such cases can be fitted. So far as the multiple spindle machine is concerned, however, direct coupling may be employed with a motor having a speed of 750 revs.

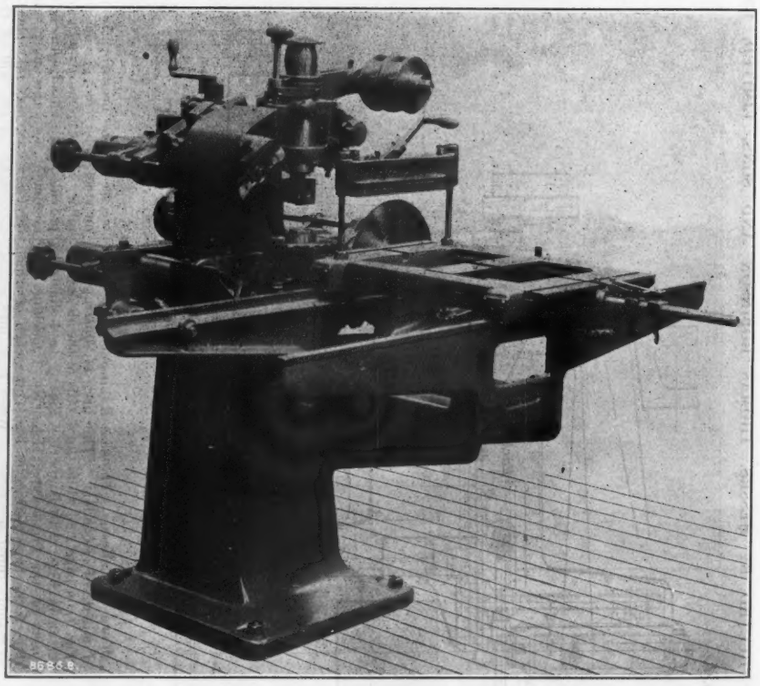


Fig. 8. General View of Machine.

INDUSTRY FROM THE INTERNATIONAL STANDPOINT.*

The time has surely come when questions of trade must be considered more from an international standpoint. But in order that this may be done the necessary organisation must exist. I am no politician, but I regret very much that the permanent Economic Committee suggested at the last Imperial Conference has not been appointed, for it might have become an imperial organisation for dealing with these wider questions. But in addition to that there is a real need for an international body to consider the international aspect of trade. Clearly this should be a function of the League of Nations. Already it deals with international labour questions and it has here a very important field of activity. But this is only one side of a bigger problem. For the good of the Empire there must be a body that can think imperially on trade questions; for the good of the world there must be a body that thinks internationally.

Meanwhile, unless we are to starve we must not only maintain, we must extend, our foreign trade to meet the needs of our growing population. It is a matter of common knowledge that at the present time the volume of our foreign trade is less than three-quarters of what it was in 1913, and even this

* Abstract of address delivered at the Independent Labour Party Summer School, Cloughton, Yorkshire, August 22, 1924, by Mr. W. L. Hichens (Chairman, Cammell Laird and Co., Limited).

is being seriously threatened. The conclusion seems to me unanswerable that we can only increase—we can only maintain—our foreign trade by cheapening production. If a man cannot afford to pay 30*s.* for a pair of boots, but is willing and able to pay 20*s.*, we must reduce our price if we wish him to be a customer. Still more, if someone else is willing to sell similar boots at 20*s.* we must reduce our price if we want customers. How is this to be done?

In the engineering trade there is undoubtedly room for the adoption of improved machinery and for better organisation. But mechanical improvement is a gradual process. On the whole, as a result of the great war-time expenditure, they are far more efficient than in pre-war days. In fact, that is one of our troubles—the development has been so great that our establishments have outrun all possible demand in the near future. The important thing for engineering is that other industries should adopt the mechanical improvements that engineers can suggest. Our docks and harbours, for instance, are often badly laid out and equipped, and it is an urgent need that they should be brought up to date. But so far as the engineering industry is concerned, more can be done by reorganisation than by re-equipment. As I have mentioned, one result of the war has been an over-development of engineering shops in this country; there is not enough work to keep them all fully employed, and some of them must go. Competition will probably eliminate the most unfit, but a more thoughtful policy is needed if unnecessary suffering is to be avoided. I think bigger units of production are necessary if we are to compete successfully against the United States and Germany. This should be achieved not so much by extending existing factories (for there are too many already) as by pursuing a policy of amalgamation. I do not suggest one big combine—that would be unwieldy and inefficient—but a moderate reduction in the number of existing units through amalgamation should, I think, be encouraged. I can see no other way in which mass production can become a reality in this country. How can you have mass production when a hundred firms are all scrambling for one order? The result is that each firm is kept barely alive by intermittent and diverse fragments.

There are two further important advantages to be gained by a wise policy of co-ordination. In the first place the larger groups will have at their disposal a wider fund of knowledge and experience upon which to draw. The experience of every member of the group will be available to all, which will result in raising the general standard of efficiency. In the second place these bigger units will be in a position to spend more money on research. There is another kind of research which is also neglected. I refer to research on the human side of the industrial organisation. Much valuable work has already been accomplished by the Industrial Fatigue Research Board, and I hope that it will continue to receive the support of the Government. I believe, too, that the industrial welfare movement has an important part to play in the human research work that ought to be carried out, provided that the direction is not dictated from above.

Capital is necessary, and since capital can only be derived from savings, thrift must be encouraged.

The vital fact for us, as I have said, is that we are dependent upon our foreign trade, and we can only maintain and develop our foreign trade if our prices compare favourably with those of our foreign rivals. At present our foreign trade in engineering products is seriously threatened by German, French, Belgian and Italian competitors, and the chief reason why they can underquote us is that their wages are lower than ours and they work longer hours. It is natural that we should wish for a higher standard of living than our European rivals, but it can only be realised if we produce more wealth per head of the population than they. If we have greater national resources, better machinery, superior organisation, a more industrious population, our standard will be higher, but not otherwise. Here again, to avoid the worst results of international competition, concerted action is necessary. And in this case the necessary organisation exists. The International Labour Office of the League of Nations exists for the purpose of dealing with problems of this character, and it should, I suggest, concentrate its attention upon the difficult problem of the relativity of wages in different countries.

COAL SLACK FIRELIGHTERS.—A company, under the title of the "Criss-Cross Firelighters, Limited," 10, Charles-street, St. James's, S.W.1, has been registered to carry on the manufacture of a patented type of firelighter. The lighters are made of a mixture of ordinary bituminous coal dust, and other materials, compressed into perforated flat slabs. Each slab is ¾ in. thick, and each lighter is made up by placing four slabs, one on the other, so as to obtain a "criss-cross" effect. The four slabs are held together by a special binding material.

ELECTRICALLY-OPERATED NAVVY FOR THE MORWELL POWER SCHEME.

THE exceptionally large and powerful navvy which we illustrate on page 292 of this issue has been constructed by Messrs. Ruston and Hornsby, Limited, Lincoln, to the order of the State Electricity Commission of Victoria, Australia, and will be used for excavating brown coal for use in connection with the Morwell power scheme for supplying electrical energy to Melbourne. The machine is similar with regard to its overall dimensions, and also in some of its design features, to the drag-line excavator which Messrs. Ruston and Hornsby constructed last year for the Sutlej irrigation scheme. The last-mentioned machine, which was the largest excavator of its type ever built in this country, was illustrated and fully described in our issues of December 21 and 28 last on pages 763 and 795. The machine now illustrated, however, differs from that for the Sutlej irrigation scheme in that it is of the crane-navvy type, as will be seen from our illustrations, and also in that it is operated by electrical power instead of by steam.

The crane-navvy type of machine, of course, excavates material from above the level on which the machine stands, and the particular excavator we are now referring to is capable of making a cut 75 ft. deep and 60 ft. wide. Its digging capacity, working in the Morwell brown coal, is estimated at 3,000 tons in a working day of 8 hours. The bucket, which is provided with four cutting teeth, has a capacity of from 10 to 12 cub. yds., and is thus capable of filling an 8-ton wagon at each cut. Owing to the great reach of the machine, wagons can be filled at a distance of 100 ft. from its axis of rotation and at a height of 70 ft. above the level on which it is working.

The excavator, as previously mentioned, is electrically operated throughout, energy being supplied at 6,600 volts alternating current and converted to direct current at 440 volts by means of transformers and a motor generator set which is illustrated in Fig. 2 on page 282. Separate motors are provided for the digging, slewing and rigging operations and also for opening the door in the bottom of the bucket to discharge its contents. The electrical equipment also includes a motor-driven air compressor and a set of flood lights to enable the work to be carried on through the night. There are two main motors for the hoisting drum which is connected to the bucket by a wire rope over 2 ins. in diameter and having a breaking strain of 150 tons. The travelling motion is of sufficient capacity to move the machine, which weighs about 350 tons in working order, up a gradient of 1 in 10.

The whole machine is mounted on a rectangular table having a four-wheeled bogie at each corner, and power for travelling is applied to each wheel. On the top of the table is a live-roller ring 30 ft. in diameter on which the revolving superstructure rests, as shown in Fig. 1, and the machine can make between 2 and 3 complete revolutions in a minute. A complete cycle of operations, including digging, slewing, dumping, slewing back into the original position and lowering the bucket ready for the next cut, can be carried out in approximately 1 minute, so that in about an hour a long train of wagons can be completely loaded with coal. Only two men are required for operating the machine, one controlling the whole of the movements and the other attending to the lubrication, &c.

The machine, as illustrated in Fig. 1, was completely erected at the makers' works before despatch, and was tested with satisfactory results in all operations, except that of actual digging. This operation, it will readily be understood, could not be carried out owing to unsuitable conditions and also on account of the large quantity of material that would need to be handled even for a comparatively short test. In Australia the machine will work in the Latrobe River Valley, where it is estimated that some 10,000,000,000 tons of brown coal are located in an area of about 60 square miles.

THE AUTOMOBILE ASSOCIATION MAP.—We have to hand an exceedingly useful hotel-location map covering Wales and the Central and South parts of England, issued by the Automobile Association. The map is supplied free to members, and is issued to assist the rapidly increasing number of motor travellers.

ALL-STEEL RAILWAY COAL WAGONS.—We understand that there is now on view at the works of the Cambrian Wagon Company, Limited, East Moors Road, Cardiff, an example of a 20-ton all-steel railway wagon for coal traffic, constructed by the firm to the specifications and drawings of the Railway Clearing House. The wagon is of the tipping type, with two side and two end doors, and is registered for main-line traffic by the Great Western Railway Company. The latter company, we may mention, offer a rebate of 5 per cent. in the railway rates in respect of coal conveyed over their system in 20-ton wagons. The new steel wagon can be inspected at the Cambrian Wagon Company's works, and further particulars of it can be obtained on application to the firm.

LABOUR NOTES.

AMONGST the resolutions passed by the "National Minority Conference" which took place in London on August 23 and 24, was one demanding "that the Trade Union Congress should instruct the General Council to call a special conference of representatives of the principal trade unions—miners, transport workers, railwaymen and metal workers—for the purpose of deciding on action to enforce an all-round increase of £1 per week." An addition calling for a minimum wage of £4 per week was also adopted. Another proposal, which found immediate favour, was that the trade union movement should be called upon "to use its organised power to institute a 44-hours maximum working week." One delegate moved as an amendment that the maximum should be 36 hours, and another that it should be 30 hours, while a third proposed that the abolition of all overtime should be insisted on. The original resolution was, however, carried by a large majority, with the addition of a demand for the abolition of all overtime and "spread-over" systems. According to Mr. Tom Mann, who presided at the Conference, adherents to the National Minority Movement "are not disruptionists or anti-trade unionists." *The Worker*, the official organ of the British Bureau of the Red International of Labour Unions—which, by the way, organised this National Minority Conference—is apparently of a different opinion. In its issue for August 23 it says: "The Minority Movement is the finest expression of a real working class challenge to the existing leadership. It represents the new spirit of struggle, as against the old spirit of jobbery. It represents the determined intention of the militant workers to make of existing workers' mass organisations the battle weapons in the Class War. It represents the surging wave of resentment against the leaders who mislead, against organisations not fitted for the fight. The National Minority Movement, gathering all the existing rebellious and militant movements into one mighty mass organisation, will be able to do what the old leaders prevented the workers from doing—to drive forward relentlessly to the final struggle for power."

Of the 105 resolutions set down for discussion at next week's Trade Union Congress in Hull, the most important, from the point of view of industry, is a proposed addition to Standing Order 12, which deals with the powers of the General Council to intervene in trade disputes. It is as follows:—

"It shall be an obligation upon the affiliated unions to keep the Council informed with regard to matters arising as between the unions and employers, and (or) between one union and another, in particular where such matters may involve directly or indirectly large bodies of workers. The General Council shall, if they deem necessary, disseminate the information as soon as possible to all unions, in the industry concerned, which are affiliated to the Trades Union Congress, and which may be either directly or indirectly affected.

"The general policy of the Council shall be that unless requested to do so by the affiliated union or unions concerned, the council shall not intervene so long as there is a prospect of whatever difference may exist on the matters in question being amicably settled by means of the machinery of negotiations existing in the trades affected.

"In the event, however, of negotiations breaking down, and the deadlock being of a character as directly or indirectly to involve other bodies of workpeople affiliated to the Trade Union Congress in a stoppage of work, and (or) to imperil standard wages or hours and conditions of employment, the Council may take the initiative by calling representatives of the unions into consultation, and use its influence to effect a just settlement of the difference. In this connection the Council, having ascertained all the facts relating to the difference, may tender its considered opinion and advice thereon to the union or unions concerned. Should the union or unions refuse the assistance or advice of the Council, the Council shall duly report to Congress.

"Where the Council intervenes, and the union or unions concerned accept the assistance and advice of the Council, and where, despite the efforts of the Council, the policy of the employers enforces a stoppage of work by strike or lock-out, the Council shall forthwith take steps to organise on behalf of the union or unions concerned all such moral and material support as the circumstances of the dispute may appear to justify."

The efforts of the Conciliation Committee appointed by the National Industrial Council for electricity supply undertakings, to consider the application of the workers for a wages increase of 10*s.* per week, succeeded so far last week as to make an immediate strike highly improbable. The Committee consisted of five representatives chosen by each side of the Council, with Mr. W. Addington Willis, nominated by the Ministry of Labour,

as chairman, and after a sitting which lasted for ten hours, it decided to recommend to the National Council "(1) that a tribunal be constituted to examine and report upon all facts material to the issues between the employers and the workers arising out of the workers' present application for an all-round increase of wages of 10*s.* per week, and to make recommendations to the National Council thereon; (2) that the tribunal do report and make their recommendations to the National Council within a reasonable time; (3) that the operation of the notices issued by the National Council on July 19 be suspended from and including the pay-day following August 20, until the National Council have accepted, rejected, or failed to agree upon the report and recommendations of the tribunal. During such time, the trade unions agree not to issue notices to stop work." These recommendations were subsequently adopted at a full meeting of the National Council. The tribunal, which held its first meeting on August 27, consists of Mr. W. Addington Willis (chairman), Aldermen G. P. Dean, Mr. John Turner, Mr. W. B. Woodhouse and Mr. Samuel Fedden. The Secretary is Mr. A. I. Whitehead, of the Ministry of Labour. The question of procedure was discussed at the meeting and it was decided that the proceedings should be public. The next meeting will be held on Wednesday, September 10.

Members of the Amalgamated Engineering Union employed by ship-repairing firms on the Bristol Channel ceased work on August 18 in support of a demand for a wages increase of 15*s.* 8*d.* per week. The employers had offered the men the same terms as were accepted by the boilermakers and allied trades, viz., 2*s.* 6*d.* per week as from July 1, and 2*s.* 6*d.* per week as from October 1, but the engineers rejected the compromise, and, by way of reprisal, stopped overtime and also the practice of appointing chargemen to the various jobs. On notices being posted by the employers to the effect that their work would be open as from August 18 to members of the A.E.U., provided that the two embargoes indicated were withdrawn and the rejected wages offer accepted, the men decided to strike, and on August 18 did so.

The differences between the building trades employers and their employees were adjusted on August 22, the executives of the unions accepting the proposals for a national agreement, and on August 25 work was resumed after a stoppage of seven weeks. The terms provide for an immediate advance in wages to all craftsmen and labourers (except in towns up-graded in September last) of one halfpenny per hour, the increased rate to be stabilised until February, 1926. In the case of towns up-graded in September last, the increase is to be paid as from October 1. Working hours are to be fixed, where possible, by local agreement, but, in any event, the summer hours (other than where varied by local agreement) are to be 46½ per week as from the beginning of Summer Time, 1925. The question of time lost through inclement weather is referred to a joint committee of employers and operatives, which is to endeavour to report within six months. The agreement is not to apply to Liverpool until December, 1925, and the Liverpool operatives are to retain their existing rate of wages until February, 1926.

Mr. Michael Farbman gave some interesting facts about Russian Labour affairs in the course of an interesting address last week to the Independent Labour Party's Summer School at Claughton. He said that the strikes in 1923 averaged the length of strikes in pre-revolutionary days, and that they were directed against both State factories and private industries. At present the scale of wages was practically the same in State industries and those run by foreign concessionaires. According to the estimate of the Central Council of Russian Trade Unions at the end of 1923, the average wages reached 60 per cent. of those paid in pre-war times. In the textile and tailoring trades, which were formerly sweated, wages were from 75 to 110 per cent. of pre-war level. In the metal industries, mining and transport, wages now paid were less than half of those received in pre-war time. There was much unemployment, and all concerned, whether State or trade union officials, held no hope of extinguishing it in the immediate future. Skilled unemployed were getting relief to the tune of 50 per cent. of subsistence minimum, and unskilled 34 per cent.

The June quarterly report of the General Federation of Trade Unions states that, during the three months, 32 disputes were registered, involving 5,826 members. The trades affected were the Quarryworkers and Settmakers, the Tailors and Garment Workers, the Vehicle Builders, the Furnishing Trades, the Upholsterers, and the Hemmers and Veiners. The total number of members is now 828,283, of whom 456,143 are on the higher scale and 372,140 on the lower scale. Entrance fees and contributions received during the quarter amounted to 13,470*l.* 11*s.* 9*d.*, and benefits paid out to 3,019*l.* 5*s.* 10*d.*

The Management Committee of the General Federation of Trade Unions states that the Amalgamated Society of Coopers asked for assistance in preventing the ratification of that portion of the Geneva Convention which prohibits the use of white lead by painters. It was urged that one serious effect of this prohibition would be the employment of white zinc, made largely in France, and that the barrels and kegs used for the transport of this white zinc would also be made in France, thus depriving British coopers of some of their customary work. It was pointed out to the coopers that, as representatives appointed by the British Trades Union Congress had advocated the prohibition of white lead, any action taken by the Management Committee of the General Federation might be construed into a reflection upon these delegates, and no action was taken.

In the August issue of *Man and Metal*, the official journal of the Iron and Steel Trades Confederation, exception is taken to some of the conclusions drawn from the large increase during May of our iron and steel imports. The rise was from 198,900 tons in April to 300,100 tons in May. The figures dropped, it is pointed out, to 175,500 tons in June, while our production of iron and steel rose to nearly its highest post-war level. Moreover, our exports increased from 336,800 tons in April to 406,900 tons in May. In our opinion, the general slackness which has followed the American slump merely proves the interdependence of modern States. With so great a falling-off in production, it is regarded as not surprising that much of the plant here should be temporarily closed down. Among the works affected are the Springvale works at Bilston, Ebbw Vale works, Redbourn Hill and Hawarden. The prospects of improved trade are considered to be greatly dependent upon the carrying out of some great national extension of electric power supply. We are being rapidly left behind by our Continental competitors, it is asserted, and should spare no effort to retrieve our position.

Writing in *Industrial and Labour Information*, the weekly publication of the International Labour Office of the League of Nations, Mr. T. Tchoü states that it has been estimated that over 70 per cent. of the working people in China work seven days a week. Only a few factories under Christian management, such as the Commercial Press Works in Shanghai, and the hair net and embroidery industries in Chefoo (which are under Christian influence), stop work on Sundays. The majority of the industrial establishments work continuously throughout the year. Some of the larger and more modern factories, however, often suspend work for one day in ten, or twice a month, for the purpose of cleaning and repairing the machinery. The number of rest days varies somewhat in different parts of the country. Work is suspended for from three days to two weeks at the Chinese New Year. The 5th of the 5th moon and the 15th of the 8th moon (being the dates for the dragon boat and mid-autumn festivals) are two general holidays.

At Rotherham last week the Court of Referees gave an important decision under the new Unemployment Insurance Act. Between 7,000 and 8,000 steel-workers employed by three firms in the district are on strike, and eight test claims—one by each of the eight unions involved in the stoppage—were heard. The new Act provides that men declining to work for firms who refuse to comply with the trade union conditions in the district shall be entitled to benefit. In this instance the men struck because of a proposal by the employers to put them on a sliding scale, which already operated in the case of other employees. The effect of the change would be, the workers contended, appreciably to reduce their wages The Court of Referees held that the strikers were entitled to benefit. The decision is, of course, subject to appeal.

A conference has taken place between the Belfast District Committee of the Federation of Engineering and Shipbuilding Trades and representatives of the Belfast Shipbuilding employers on the subject of the men's application for an increase in wages of 20*s.* per week. The representatives of the workers were informed that while the employers could not grant the advance demanded they were prepared to concede the same terms as had been accepted by the men employed in federated shipyards, *viz.*, an increase of 7*s.* per week in two instalments. An application on behalf of engineers for the restoration of the remaining half of the 10*s.* war bonus was also considered.

Representatives of the Amalgamated Engineering Union and other craft unions with members employed in railway shops, as well as representatives of the National Union of Railwaymen, attended the conference convened last week by the General Council of the Trades Union Congress for the purpose of formulating, if possible, a common policy on the wages question. It was decided to recommend the General Council to consider the matter in the light of the discussion which had taken place, and to appoint a sub-committee to consult with the unions concerned with a view to submitting suitable proposals. A report is to be given to the forthcoming Trades Union Congress at Hull.

The Industrial Court has issued its award on a claim by the Trade Union side of the Shipbuilding Trades Council for Government Departments for an increase of 3*s.* per week to men employed in the Admiralty establishments at Wrabness and Crombie. The ground of the application was that, owing to the absence of sufficient housing accommodation in the vicinity of these depots, the bulk of the men were forced to live elsewhere, which, apart from the time occupied in getting to and from work, necessitated unusually heavy expenses for railway fares, or obliged them to walk or cycle exceptional distances and involved them in additional expenses for meals. It was submitted by the official side of the Council that travelling expenses were only one of the items to be taken into account, that if the workmen's expenditure was to be examined in detail various other factors (such as rent) would have to be taken into consideration, and, generally, that it was undesirable on the facts in the present cases to make a departure from the recognised Admiralty practice. The decision of the Court is that neither at Wrabness nor at Crombie are there such peculiar local conditions as entitle the men concerned to the payment of rates in excess of those commonly paid throughout the Royal Dockyards and other Admiralty establishments.

An increase of 30,357 in unemployed persons on the registers of employment exchanges in Great Britain during the week ended August 18 brings the total increase in the number of unemployed persons during the last eight weeks to over 112,000. The unemployment figures, which had been falling steadily from early in February, began to rise at the end of June, and weekly increases ranging from 1,442 to 32,239 have been recorded since that time. The proportion of unemployed workers has, consequently, risen from 9·4 per cent. in June to about 11 per cent. at the present time. Part of the additional unemployment is doubtless due to seasonal changes, but the bulk of it arises from slackness of trade caused by foreign competition and to the weakness of markets abroad. The coal-mining industry shows the largest individual increase in unemployment. At the end of May the unemployed in this industry represented 3 per cent. of the insured workers, but the proportion had increased to 6·8 per cent. by the end of July, and the figure has been steadily increasing during the current month. In the iron and steel industry the position is even worse, since the depression has existed for a longer period. On July 28 the proportion of iron and steel workers unemployed was 19·6 per cent., showing an increase of 2·9 per cent. in two months. The condition in this industry is almost entirely due to the competition of German and Belgian producers.

According to *The Labour Gazette*, employment in the engineering trades continued bad in July, and failed, on the whole, to maintain the progressive tendency shown in recent months. In general engineering there was a further improvement, but in the motor and cycle section employment, though fairly good, showed a seasonal decline. In textile engineering employment was still depressed, but showed a further slight improvement; in marine engineering it was also depressed, and failed to maintain the improvement reported in June. In railway engineering employment was fair, but showed a decline on the previous month; in electrical engineering it continued fairly good. In the shipbuilding and ship-repairing trades employment continued very bad, but showed a further slight improvement. Employment in the other metal trades was moderate to fair on the whole, and showed little general change as compared with June. It was fairly good in the hollow-ware and edge tool trades; fair in the sheet metal, metallic bedstead, brass, cutlery, file, stove and grate, tube and spring trades; moderate in the wire, and in the saddle and harness furniture trades; and slack or bad in the chain, anchor, needle, fishing tackle, nut, bolt, nail, lock, latch, key and jewellery and plated ware trades.

The present position with regard to the strike of porters at Covent Garden market is that the Ministry of Labour has sent a second invitation to the employers to state their case. The National Council of Port Labour Employers has called upon the Union to cancel its instructions for the non-handling of fruit and vegetables, which instruction the employers regard as a breach of the national agreement.

THE WATER POWER RESOURCES OF CANADA.*

By J. B. CHALLIES.

WITH an increase during the year 1923 of over a quarter of a million horse-power the total hydraulic power installation of Canada has now reached 3,227,414 h.p., while the growing demand for power is demonstrated by the numerous large developments being rapidly pushed to completion. These new developments are not confined to any particular section of the country but extend from coast to coast and are designed to serve practically every community where a demand for power exists.

While complete data regarding Canada's large water power resources are not yet available, a great mass of reasonably accurate, as well as considerable specific, data is now available in the records of the Dominion Water Power Branch of the Department of the Interior. During the past four years all existing stream flow and power data available from Federal, Provincial and private sources have been systematically collated, re-analysed and co-ordinated with a view to preparing revised estimates of available power based on uniform methods of computation and arrangement.

TABLE I.—*Available and Developed Water Power in Canada, February 24, 1924.*

Province.	Available 24-hour Power at 80 per cent. Efficiency.		Turbine Installation.
	At ordinary min. flow h.p.	At ordinary 6-months flow h.p.	
1.	2.	3.	4.
British Columbia ..	1,931,142	5,103,460	355,517
Alberta ..	475,281	1,137,505	33,067
Saskatchewan ..	513,481	1,087,756	—
Manitoba ..	3,270,491	5,769,444	162,025
Ontario ..	4,950,300	6,808,190	1,445,480
Quebec ..	6,915,244	11,640,052	1,116,398
New Brunswick ..	50,406	120,807	44,539
Nova Scotia ..	20,751	128,264	54,950
Prince Edward Is. ..	3,000	5,270	2,239
Yukon and North-West Territories ..	125,220	275,250	13,199
	18,255,316	32,075,998	3,227,414

The figures listed in Columns 2 and 3 in the above table represent 24-hr. power and are based upon rapids, falls and power sites of which the actual existent drop or the head possible of concentration is definitely known or at least well established. Many rapids and falls of greater or lesser power capacity are scattered on rivers and streams from coast to coast which are not as yet recorded, and which will only become available for tabulation as more detailed survey work is undertaken and completed. This is particularly true in the more unexplored northern districts. Nor is any consideration given to the power concentrations which are feasible on rivers and streams of gradual gradient, where economic heads may be created by the construction of power dams, excepting only at such points as definite studies have been carried out and the results made matters of record.

The figures in Column 4 represent the actual water wheels installed throughout the Dominion. These figures should not be placed in direct comparison with the available power figures in Columns 2 and 3 for the purpose of deducting therefrom the percentage of the available water power resources developed to date. The actual water wheel installation throughout the Dominion averages 30 per cent. greater than corresponding maximum available power figures calculated as in Column 3. The figures quoted above, therefore, indicate that the *at present recorded water power resources* of the Dominion will permit of a turbine installation of 41,700,000 h.p. In other words, the present turbine installation represents only 8 per cent. of the present recorded water power resources.

The above figures may be said to represent the *minimum water power possibilities* of the Dominion.

As illustrative of this the detailed analyses which have been made of the water power resources of the provinces of New Brunswick and Nova Scotia have disclosed most advantageous reservoir facilities for regulating stream flow, and it is estimated that the two provinces possess within their respective borders 200,000 and 300,000 commercial horse-power. These figures provide for a diversity factor between installed power and consumers' demands.

The estimates in Table I have been calculated on the basis of 24-hour power at 80 per cent efficiency for conditions of "Ordinary Minimum Flow" and "Ordinary Six Months' Flow." The "Ordinary Minimum Flow" is based on the averages of the minimum flow for the lowest two consecutive seven-day periods in each year, over the period for which records are available. The "Ordinary Six Months' Flow" is based upon the continuous power indicated by the flow of the stream for six months in the year. The actual method to determine this flow is to arrange the months of each year according to the day of the lowest flow in each. The lowest of the six high months is taken as the basic month. The average flow of the lowest seven consecutive days in this month determines the maximum for that year. The average of such maximum figures for all years in the period for which data are available is the estimated maximum used in the calculation.

This estimated maximum development is based upon the assumption that it is good commercial practice to develop wheel installation up to an amount, the continued operation of which can be assured during six months of the year, on the assumption that the deficiency in power during the remainder of the year can be profitably provided from storage or by the installation of fuel power plants as auxiliaries. The correctness or otherwise, of this assumption for any particular site can only be definitely settled by careful consideration of all circumstances and conditions pertinent to its development. The method, however, enables us to make a fairly satisfactory over-all estimate of the maximum hydraulic power available as distinctive from the estimated ordinary minimum power available.

Available and Developed Totals.—The known available water power in Canada, from all sources and within the limitations outlined, is 18,255,000 h.p. for conditions of ordinary minimum flow and 32,076,000 h.p. under a flow estimated for maximum development, *i.e.*, dependable for at least six months of the year. It is believed that these are conservative estimates, since an analysis of the water power plants scattered from coast to coast concerning which complete data are available as to turbine installation and satisfactory information as to stream flow, gives an average machine installation 30 per cent. greater than the six-month flow maximum power. Applying this, the figures quoted above, therefore, indicate that the present recorded water power resources of the Dominion will permit of a turbine installation of 41,700,000 h.p. The total installation to date in waterwheels and turbines through the Dominion is 3,227,414 h.p. In other words the present turbine installation represents only 8 per cent. of the recorded water power resources.

Current Progress.—With the passing of the period of abnormally high and uncertain construction costs a general expansion of water power development is taking place. Among the many developments at present under way in the various provinces of the Dominion may be mentioned the following:

In British Columbia the East Kootenay Power Company is constructing a 15,000 h.p. central electric station, the Granby Consolidated Mining, Smelting and Power Company and The Pacific Mills Limited, have added 5,000 h.p. and 6,300 h.p. respectively to their present mining and pulp and paper installations, while the British Columbia Electric Railway Company is preparing to install a 25,000 h.p. unit in its Stave Falls station. The Manitoba Power Company has installed two units of 28,000 h.p. each in its new power house at Great Falls, Manitoba and expect to add a third similar unit this year. The City of Winnipeg also intends adding 3 units totalling 20,700 h.p. to its Point du Bois station. The Hydro-Electric Power Commission of Ontario installed 130,600 h.p. during 1923, bringing its total installation to 746,029 h.p. and expect to have an additional 147,000 h.p. in place before the end of 1924. Power for the mining district of Northern Ontario has been augmented by over 9,000 h.p., a 4,000 h.p. development being completed by the Lower Sturgeon Power Company and a similar station by the Great Northern Power Company, while additional power has been provided in existing stations. Before the end of 1924, an additional 45,000 h.p. is expected to be available from the Quinze River* development of the Northern Canada Power Company and the Abitibi River development of the Hollinger Consolidated Gold Mines, Limited. In Quebec there have been installed in various central stations some 30,000 h.p. during 1923, and construction work already under way provides for an additional 385,000 by the end of 1924, 280,000 h.p. of which will be in the great power stations of the Quebec Development Company on the Saguenay River and of the St. Maurice Power Company at La Gabelle. The year 1923 has seen substantial additions to existing central electric stations in the Maritime Provinces with further additions promised for 1924.

In summarising the above figures, it may be pointed out that, while the total addition to Canada's hydraulic installation during the year 1923 amounted to 255,000 h.p., there are at the present time actually in process of construction or in active prospect further hydraulic developments amounting to more than 900,000 h.p. The progress of development is somewhat difficult to follow from year to year because of the magnitude of the operations involved. From three to five years, or even longer, may elapse between the preliminary surveys and the delivery of power. Again, most projects commence with an initial installation much less than the ultimate projected capacity, new power units being added as the load develops.

TABLE II.—DEVELOPED WATER POWER IN CANADA.

Province.	Turbine Installation in H.P.				Population, June 1, 1923	Total Installation per 1,000 Population.
	In Central Stations.	In Pulp and Paper Mills.	In Other Industries.	Total.		
1	2	3	4	5	6	7
British Columbia ..	242,401	55,140	57,976	355,517	553,500	642
Alberta ..	32,380	—	687	33,067	634,200	52
Saskatchewan ..	—	—	—	—	814,200	—
Manitoba ..	145,625	—	16,400	162,025	642,800	252
Ontario ..	1,142,403	174,189	128,888	1,445,480	3,028,900	477
Quebec ..	791,795	237,232	87,371	1,116,398	2,443,500	457
New Brunswick ..	23,613	13,728	7,198	44,539	396,900	112
Nova Scotia ..	23,196	17,331	14,423	54,950	532,600	103
Prince Edward Island ..	288	—	1,951	2,239	88,000	25
Yukon and North West Territory ..	10,000	—	3,199	13,199	11,400	1,158
Canada	2,411,701	497,620	318,093	3,227,414	9,146,000	353

Column 2 includes only hydro-electric stations which develop power for sale.

Column 3 includes only water power actually developed by pulp and paper companies. In addition to this total, pulp and paper companies purchase from the hydro-power central stations totalled in column 2, 96,985 h.p. in Ontario, 131,120 h.p. in Quebec and 650 h.p. in New Brunswick. The total hydro power utilised in the pulp and paper industry is therefore 726,375 h.p.

Column 4 includes only water power actually developed in connection with industries other than the central station and the pulp and paper industries. These industries also purchase blocks of power from the central stations totalled in Column 2.

Column 5 totals all turbines and water wheels installed in Canada.

Column 6 population at June 1, 1923, as estimated by Dominion Bureau of Statistics.

Column 7 averages the developed water power per 1,000 population.

Utilisation of Developed Water Power.—The 2,973,759 h.p. at present installed in this country may be classified as follows (see Table II):—2,411,701 h.p. in central stations for general distribution for all purposes; 497,620 h.p. installed in pulp and paper mills, not including 228,755 h.p. purchased by pulp and paper companies from central stations; 318,093 h.p. installed in industries other than central stations and pulp and paper mills. The total installation for the Dominion averages 353 h.p. per thousand population—a figure which places Canada third in the *per capita* utilisation of water power among the countries of the world, Norway and Switzerland only having a higher *per capita* utilisation.

Water Power in the Central Station Industry.—Modern developments in high-tension electrical transmission, which permits the economic transportation of power at small loss over relatively long distances, has made possible the use of hydraulic power for manufacturing in established centres where labour is plentiful and of a permanent character, with shipping and distributing facilities readily at hand. Such centres, with their variety of manufacturing needs and processes, street railways to be operated, buildings to be lighted and heated, municipal needs for street lighting and water pumping, form an ideal market for the product of the central electric station and have resulted in the central station industry attaining enormous proportions in a relatively short period of time.

Throughout the Dominion at present there are 282 hydro-electric central stations with an installed turbine capacity of 2,411,701 h.p. or a generator installation of 1,815,604 kv.a. (see Table III), of which totals 1,644,071 h.p. are installed in commercial or privately owned stations, while 767,630 h.p. are installed in municipal or publicly owned stations. The units vary in size from 10 h.p. to the 55,000-h.p. turbines recently installed in the Queenston Development of the Ontario Hydro-Electric Power Commission. The turbine units in the industry average 3,682 h.p., while the average installation of the central stations is 8,552 h.p. Unremitting progress in operating efficiency and wider fields of service are being constantly maintained by the operating companies and interested Government departments. New units are being installed, new

* Paper read before Section G of the British Association at Toronto on behalf of the Dominion Water Power Branch of the Department of the Interior of the Canadian Government, Friday, August 8, 1924.

* Wholly in the Province of Quebec.

plants constructed, new projects investigated, and research instigated to meet the growing domestic and industrial demand and to link up the hitherto isolated small centres and rural districts with cheap hydro-electric power.

Water Power in the Pulp and Paper Industry.—Pulp and paper manufacturing is a typical and prominent Canadian industry with a future of almost unlimited prosperity ahead of it, the result of two natural advantages of almost equal moment, namely, an abundant supply of growing pulpwood and low-priced and easily accessible motive power in large quantities. The importance of low-priced power lies in the fact that it takes practically 100 h.p. to produce one ton of paper per day.

It is not surprising, therefore, that motive power used in this industry is almost altogether restricted to hydraulic energy, and that Canada's premier advantage and position in the pulp and paper field rests on adequate and abundant water power well distributed among extensive forest reserves. Water power is operating 121 pulp and paper mills in Canada, 726,375 h.p. being employed. Of this total, 497,620 h.p. are actually installed in connection with the mills and 228,755 h.p. are purchased from hydro-electric central stations.

The innovation of the electric drive is having marked and favourable influence on pulp and paper-manufacturing processes. It makes possible the centralised operation of fewer and larger mills receiving power from several power sites, together with the further advantage of uniform speed and better control in grinding, thus lessening costs of operation, construction, and shipping. Of the 497,620 h.p. actually installed in pulp and paper mills 210,053 h.p. are used in the electric drive, besides which there are 228,755 h.p. of hydro-electric energy purchased from central stations, bringing the total horse-power employed in the electric drive up to 438,808.

Quebec and Ontario possess the largest natural pulpwood areas in Canada, and they lead in pulp and paper production with 368,352 h.p. utilised in this industry in Quebec and 271,174 h.p. in Ontario. Other producing provinces are: British Columbia, 55,140 h.p.; New Brunswick, 14,378 h.p.; and Nova Scotia, 17,331 h.p.

Past and Future Growth in Utilisation of Water Power.—The growth of water-power developments in Canada has been striking. The total installed horse-power has grown from 975,000 to 3,227,000 since 1910, central-station installations from 605,000 to 2,411,701 h.p., and pulp and paper installations from 191,000 to 498,000 h.p. There is every reason to believe that this rate of growth will not diminish. New uses for electric current of the greatest import in industrial processes and services are being constantly discovered. Canada's strategic advantage in the location of large reserves of water power within transmission distance of her centres of population should attract special industries to these centres in increasing numbers. Population follows industry, and at once an added market is created for power for domestic and municipal uses. All the modern tendencies in the utilisation of cheap power indicate that the rate of growth of hydro-electric development in Canada will increase rather than lessen.

Should the rate of installation since 1910 be maintained at its present rate there will be installed in 1925 4,000,000 h.p., in 1930 5,000,000 h.p., in 1935 6,000,000 h.p., and in 1940 7,000,000 h.p. These growth figures are considered conservative, as the rate of growth since 1920 has been considerably in excess of the rate over the whole period from 1910. Available reserves are more than ample to take care of these future demands, as outlined, for a long time to come. The water power now developed in Canada represents an investment of over 687,000,000 dols. In 1940, should the rate of growth in installation during the past fifteen years be continued, this investment will have grown to over 1,500,000,000 dols. The present development represents an annual equivalent of 29,000,000 tons of coal, which, valued at 10 dols. per ton, represents 290,000,000 dols. In the year 1940 these annual figures will, with the foregoing assumption, have become 63,000,000 tons and 630,000,000 dols. These figures are striking evidence of the outstanding importance and necessity of an intelligent administrative policy governing the development of our water-power resources.

TABLE III.—Developed Water Power in Canada Utilised in the Central Station Industry.

Province.	Commercial Stations.			Municipal Stations.			Total.				
	No.	Installation.		No.	Installation.		No.	Installation.			
		Generator. K.V.A.	Turbine. H.P.		Generator. K.V.A.	Turbine. H.P.		Generator. K.V.A.	H.P. per Turbine Unit.	H.P. per Station.	Total Turbine H.P.
1	2	3	4	5	6	7	8	9	10	11	12
British Columbia ..	24	153,686	232,356	8	6,353	10,045	32	160,039	4,108	7,375	242,401
Alberta	3	22,250	32,380	—	—	—	3	22,250	2,414	10,793	32,380
Saskatchewan ..	—	—	—	—	—	—	—	—	—	—	—
Manitoba	4	58,350	78,400	2	57,312	67,225	6	115,662	6,935	24,271	145,625
Ontario	69	395,659	503,375	37	457,472	639,028	106	853,131	4,109	10,777	1,142,403
Quebec	79	606,813	771,820	17	14,962	19,975	96	621,775	3,552	8,248	791,795
New Brunswick ..	7	8,460	11,703	3	9,363	11,910	10	17,823	1,073	2,361	23,613
Nova Scotia ..	9	3,204	3,749	12	15,389	19,447	21	18,593	828	1,124	23,196
Prince Edward Is.	7	331	288	—	—	—	7	331	32	41	288
Yukon	1	6,000	10,000	—	—	—	1	6,000	5,000	10,000	10,000
Canada	203	1,254,753	1,644,071	79	560,851	767,630	282	1,815,604	3,682	8,552	2,411,701

Commercial stations include all privately owned.
Municipal Stations include all publicly owned.
Note.—Statistics in this table are based upon a census of the industry made by the Dominion Bureau of Statistics in co-operation with the Dominion Water Power Branch.

COBALT MAGNET STEELS.*

By E. A. Watson, M.Sc.

(*Concluded from page 276.*)

Heat Treatment.—From the viewpoint of the hardened steel which constitutes a permanent magnet, the reactions of the various constituents in the annealed bar are not of great importance, and we are not seriously concerned with the equilibrium of the cobalt-ferrite, and the various carbides which may be present in the material in the unhardened state. What do concern us are the factors which affect the retention of the carbides in solution during the hardening process, and the way in which the hardening temperatures and cooling rate depend upon the analysis of the steel which is being treated. Arnold and Read (9) have shown that in an annealed iron-cobalt-carbon steel the carbon is principally present in the form of iron-carbide or cementite, Fe_3C., which forms a species of pearlite with a cobalt ferrite, *i.e.*, the solid solution of Fe_2Co in Fe. A small percentage of the carbon would, however, appear to be present in the form of a carbide of cobalt Co_3C in true solution in the cobalt-ferrite.

The most noteworthy feature of their work, however, is that portion dealing with the effect of cobalt in promoting separation of graphite upon annealing. The tendency to precipitate graphite during annealing increases rapidly as the cobalt content rises, and they found that, with bars containing upwards of 10 per cent. cobalt with about 0·8 per cent. carbon, the whole of the carbon was precipitated as graphite after annealing for about 24–30 hours at 780 deg. C. Although the actual precipitation of graphite can be prevented by the addition of chromium, the annealing of all cobalt steels requires to be carried out with considerable care, and prolonged soaking at temperatures upwards of 700 deg. C. must be avoided, as practically all steels deteriorate very considerably in their ultimate magnetic properties under such treatment.

It is possibly also for a similar reason that rapid heating of a cobalt steel to the hardening point is always desirable. In general, the time taken to raise the magnet to the hardening temperature, 950 deg. C. or 1,000 deg. C., should not exceed 15 minutes, and the best results are usually obtained with from 8 to 10 minutes or even less. The furnace used, therefore requires to be one which is capable of putting heat into the work at the maximum possible rate, consistent with obtaining an even temperature. Gas-fired muffles, with recuperator tubes, and working at atmospheric pressure have, in general, been found to give excellent results. Electric furnaces have been tried, but not found satisfactory, as with the exception of the salt-bath furnace it is difficult to obtain a sufficiently rapid heating of the steel. It has, in certain cases, been found advantageous to conduct the hardening operation in two muffles, the first heating the magnet up to about 750 deg. C., and the second carrying the temperature from this point to the hardening point, This reduces the cooling of the high-temperature muffle by the insertion of a cold charge and gives quicker production, and it also assists, in certain steels, in reducing the risk of cracking during hardening.

Effect on Hardening Conditions.—Data as to the effect of cobalt on the various transformation points of an alloy steel are very incomplete. In some cases, a raising of the A1 point can be traced, notably with the 35 per cent. alloys, but apart from this the presence of cobalt has little effect upon the thermal characteristics of the steel. A water-hardening steel, in which certain of the iron content is replaced by cobalt, remains water hardening. An oil-hardening one remains oil hardening, and an air-hardening steel is still air hardening. Precise data are lacking, or at least are not available, on any given series of steels, and it might be found that the substitution of cobalt had some slight effect upon the correct cooling rate for a given carbon or alloy content, but if so, the effect is small in comparison with that of the other elements, chromium, tungsten, or carbon, which go to make up a magnet steel. Hence it is that the straight carbon steels require brine quenching to obtain the best results, even when as much as 30 per cent. cobalt is present, while oil hardening is best for cobalt chrome-tungsten steels with medium carbon content, and air hardening can be employed for the high-chrome, high-carbon steels. Practically all the cobalt steels used in commerce show a very clearly marked absorption point between 840 deg. C. and 900 deg. C., and hardening can be carried out from temperatures immediately above this point. With certain of the high-carbon steels the best results are obtained with hardening temperatures as high as 1,000 deg. C., but the majority require to be quenched within a comparatively narrow range, lying between the temperatures of 920 deg. C. and 960 deg. C. The behaviour of the high-carbon, high-chromium steels is probably analogous to that of the ordinary hyper-eutectoid carbon steels, in that an increased temperature is necessary to ensure complete solution of the carbon.

Heat Treatment of High-Carbon, High-Alloy Steels.—In order to obtain the best magnetic results from steels of this class it is not, as a general rule, sufficient merely to heat the annealed bar to the hardening point and quench or cool in air, as may be necessary. Such a treatment will, of course, harden the steel and give fairly good magnetic results, but an improvement of from 10 per cent. to 20 per cent. can usually be obtained by following what is termed the "triple treatment," first originated by Mr. Kayser in connection with the cobalt-chromium series of steels. This treatment consists in first of all heating the magnet fairly quickly to 1,150 deg. C., allowing it to remain at this temperature for about five minutes, and then cooling in air. After this treatment the steel is in the austenitic state, and almost completely non-magnetic. If the treatment has been properly carried out, the remanence will not exceed 1,500 to 2,000. As soon as they have cooled to atmospheric temperature the magnets are re-heated. At about 700 deg. C. a very marked recalescence occurs, and the magnets glow up brightly, the temperature rising spontaneously to about 800 deg. C.

This recalescence is, of course, due to the breakdown of the austenite in the steel, which now becomes magnetic, the remanence after cooling rising to about 8,000. As soon as the steel has cooled to atmospheric temperature, it may be reheated to the true hardening point, in the case of the cobalt-chrome series 980 deg. C. to 1,000 deg. C.

In the case of certain steels, and particularly when the composition approaches more closely to the medium alloy type, the 750 deg. treatment may be omitted, as the austenite breaks down sufficiently rapidly during the ordinary heating to the hardening point, or, as an alternative, the magnet may be transferred directly from the 750 deg. furnace to the final hardening. In the case of the air-hardening, high-alloy steels, this, however, is not as a rule effective, as the resultant product will usually show a low remanence due to the retention of austenite.

Although this triple treatment usually shows to greatest advantage on the high-alloy type of steel, it will usually be found to effect a well-marked improvement on the medium-alloy steels in addition, and is frequently of value when the highest possible coercive force is required. With a 35 per cent. medium-alloy steel, coercive forces of upwards of 300 have been

* Paper read before Section G of the British Association at Toronto on August 13, 1924.

obtained by the use of the triple treatment. The reason for the improvement effected by this treatment is probably the more complete solution of the carbides which can thus be effected. It is found that, as a general rule, the effect of annealing on a high-alloy steel is to produce a diminution in the magnetic properties in the hardened magnet, the diminution being the greater the longer the annealing treatment, and the softer the resultant steel. Provided the annealing has not been carried to excess, its effect can be counteracted by the use of the triple treatment. In all probability, annealing produces a gradual segregation of the constituents, and the segregated carbides are unable, in the ordinary way, to go into solution with sufficient rapidity at the hardening temperature. In fact, in extreme cases it is possible to determine their presence microscopically. Heating to 1,150 deg. C., however, doubtless causes complete solution of the carbides, and the quick annealing at 750 deg., which follows this, while throwing them out of solution again, does not give time for segregation. Consequently, on heating again to the hardening temperature they are readily absorbed, and a larger amount of carbide is obtained in solution than when a single treatment is used. On this basis, the greatest improvement in properties will naturally be obtainable in the case of the high-carbon steels, and no improvement is to be expected in the case of those of lower carbon content.

Importance of Cooling Rate.—The fact that some of the most efficient magnet steels belong to the air-hardening, cobalt-chromium class has been instrumental in throwing a large amount of light upon the mechanism of the hardening of a permanent magnet, and increasing our knowledge of the points to which attention must be paid if satisfactory results are to be obtained. These have in part been published elsewhere (7*b*), but it is proposed to recapitulate the more important points involved, as it is felt that they are essential to the remainder of this paper :—

(1) The cooling rate must be sufficiently rapid to suppress the ordinary recalescence point, in this case at about 750 deg. C., at which segregation of carbides and ferrite can occur. (2) In place of the normal recalescence at about 750 deg. C., an evolution of heat, due to the change of state of the gamma iron, occurs at a much lower temperature, and usually spreads out over a considerable temperature range. This change of state is accompanied by the reappearance of magnetic properties. (3) The lower the temperature at which this change of state occurs, the less the possibility of separation of cementite and ferrite or their equivalents, and the higher the coercive force and BH maximum of the magnet. The change must, however, be complete, as any unchanged material will take the form of non-magnetic austenite. As far as present information goes, however, there is no gain obtained by making the change occur below ordinary room temperatures. In some cases a distinct loss in properties is observed under such conditions.

The cooling rate must be sufficient to suppress the normal change point at about 750 deg. C., but once this is safely past, cooling rate has little or no effect upon the point at which the magnetic properties reappear, and the temperature at which the transformation occurs depends only on the maximum temperature from which the steel is being cooled. In general, once the magnetic properties commence to reappear, the quicker the cooling, the higher the remanence and the lower the coercive force, a somewhat anomalous result for which there is, as yet, no satisfactory explanation. (4) The change of state must not be interrupted, but must occur uniformly over the temperature range required to complete it, *i.e.*, assuming the change to commence at 150 deg. C. and to be complete at 50 deg. C., it would not be equally effective to make it in two parts from 150 deg. C. to 100 deg. C. and from 100 deg. C. to 50 deg. C. with a break in between. (5) The change of state appears to commence at the boundaries of the crystal grains and to spread inwards. The temperature range of its occurrence and the cooling rate required may, therefore, be appreciably affected by the grain size, particularly when one remembers that the transformation of austenite to martensite is accompanied by large volume changes, which, by introducing large mechanical stresses in the interior of the grains may tend to inhibit the transformation.

In the case of the cobalt-chromium steels, it is possible to trace clearly the changes, both thermal, magnetic and dimensional, which accompany the hardening of the steel, and although it is not possible to study the transformation of oil- or water-hardened steels in the same way, it is certain that the same general principles apply. It is perhaps scarcely realised how close to atmospheric temperature is the actual transformation point of a hardened magnet. In many cases the author has known a difference of oil temperature of some 20 deg. C. to make all the difference between no trouble in the hardening shop and a large percentage of rejects, while the difference in average magnetic values between summer and winter hardening is always clearly marked.

The large liberation of heat due to the transformation is frequently very noticeable if a magnet is removed from the quenching bath before its hardening is completed, the increase in temperature which occurs being much greater than could be accounted for on the basis of more conduction of heat from the interior of the steel. In general with air-hardening steels, the highest values of BH max. and the most consistent results have been obtained by cooling in air until magnetic properties commence to reappear, and then quenching the magnet in cold oil. The most satisfactory method of carrying out this operation is to draw the magnets from the furnace and lay them on a grid, through which a stream of air is blown by an ordinary electric fan. A fairly powerful horseshoe magnet is passed over them, and any which adhere to it are picked up and shaken off into the cooling tank, the horseshoe magnet being passed repeatedly over the cooling magnets until the whole have been picked up. It will be found that the time required for the reappearance of magnetic properties, and the temperature at which these reappear, form useful checks upon the hardening temperature, and also upon the composition of the steel.

Fig. 6. RELATION OF COST & FIGURE OF MERIT TO COBALT CONTENT. COBALT COST 12·5/- PER LB. (UNCAST)

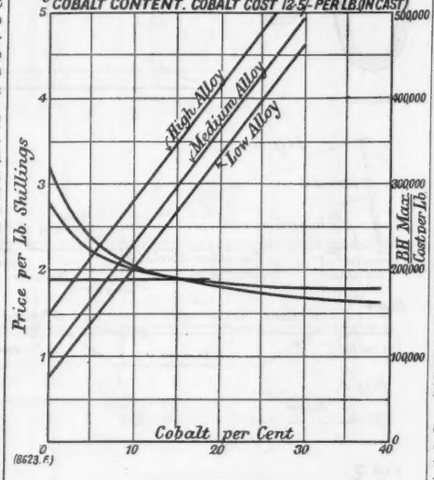
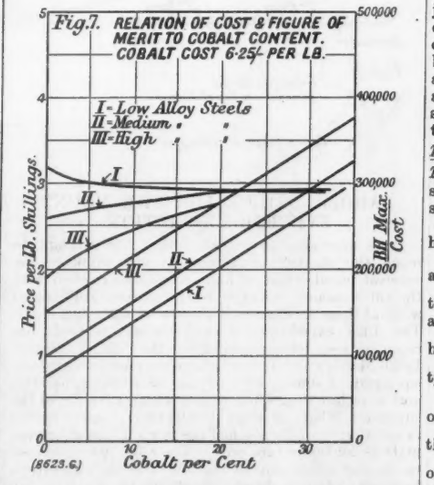


Fig. 7. RELATION OF COST & FIGURE OF MERIT TO COBALT CONTENT. COBALT COST 6·25/- PER LB.



SECTION III.

Economical Aspect of the Employment of Cobalt Steels.—It is not proposed in this paper to undertake a detailed consideration of the economic factors controlling the utilisation of cobalt steel, as it would be quite impossible to do justice to them in a general review of this sort. It is only proposed to give the general lines on which a consideration of the economics of their utilisation should be based. The problem may be looked at broadly under three aspects :—(1) The relative costs of cobalt-, tungsten-, and chrome-steel magnets for the same duty. (2) The incidental saving which the introduction of cobalt steel may render possible, such savings including reduction of dimensions, weight, and cost in other portions of the apparatus. (3) The application of permanent magnets to certain classes of apparatus where, for various reasons such as weight and dimensions, their use was not previously practicable.

Taking the first of these, it is, of course, a simple matter to calculate the additional cost of any given cobalt percentage in a magnet steel and to compare it with the increase which is obtained in the value of BH max., and we may, as a rough criterion, take the value of the ratio $\frac{\text{BH max.}}{\text{price per lb.}}$ as a figure of merit for a given steel. We have already seen that the quantity BH max. may be expressed by the relation

$$P = P_0 (1 + k' Co)$$

and to a fairly close approximation we can express the cost of the steel by a similar relation—

$$p = p_o + p_c Co$$

where p_o is the cost of the basis alloy and p_c the difference in the cost per pound of cobalt, and the iron which it replaces. In view of the present high price of cobalt, it is sufficiently accurate to take p_c as the cost of cobalt itself. Since some allowance must be made for the loss of cobalt in melting, grinding, &c., p_c must represent, not the price per pound of virgin metal, but that of the metal plus a certain percentage to cover loss and handling. This will be taken as 25 per cent.

The figure of merit of the steel may be written as :—

$$\frac{\text{BH max.}}{\text{price per lb.}} = \frac{P}{p} = \frac{P_o (1 + k'Co)}{p_o + p_c Co} = \frac{P_o}{p_o} \cdot \frac{1 + k'Co}{1 + \frac{p_c}{p_o} Co}.$$

This figure of merit will be increased, or diminished, by the addition of cobalt, according as k' is greater or less than $\frac{p_c}{p_o}$, and since the value of k' only varies slightly with different steels (see Table I, page 276 *ante*), it is clear that the steels to which it will pay to add cobalt are those which have the lowest value of $\frac{p_c}{p_o}$, *i.e.* the more expensive alloy steels, while the addition of cobalt to the cheap low-carbon, low-alloy steels is clearly not justified.

If, moreover, we take the present-day prices of cobalt and of the ordinary tungsten and chrome steels of commerce, we shall see that in no case is the condition fulfilled, and in every case the fraction is less than unity; that is, the utilisation of cobalt is not justified on the cost of the magnet alone in the absence of any other special circumstances. It is a little difficult to quote prices with any degree of exactitude, but if we take the price of virgin cobalt at 10*s.* per lb., and p_c as 12·5*s.*, and take the price of tungsten steel as 1*s.* per lb. as corresponding to the one class of alloy steel, and chrome steel at 0·75*s.* per lb. as corresponding to the other, we obtain for the two cases values of $\frac{p_c}{p_o}$ of 12·5 and 16·7 respectively—*i.e.*, very considerably more than the value of k', which we have seen varies from 7·1 to 8·4.

It is only when we come to deal with steels of the high-chromium class, which have a basis price of about 1·5*s.* per lb., giving a value of $\frac{p}{p_o}$ of 8·35, that the addition of cobalt becomes economically justifiable, and even these steels cannot compare on a simple basis of $\frac{\text{BH max.}}{\text{cost}}$ with steels of the simpler and cheaper type.

In order to bring out the comparison more clearly, on Fig. 6 have been plotted both cost per pound and the value of $\frac{\text{BH max.}}{\text{cost per lb.}}$ for the three principal classes of steel—high, medium, and low alloy. It will be seen that, for low-cobalt contents, the cheap low-alloy steel has a much higher figure of merit than either of its two competitors, and that the addition of cobalt, both to this and to the medium-alloy type, only results in a reduction in the figure of merit. In the case of the high-alloy steel, however, owing to the high initial cost, the addition of cobalt is justified, as the figure of merit rises slightly up to the limit (about 20 per cent.) which experience shows can be employed. The curves for all three steels intersect at about 15 per cent. cobalt.

As a matter of interest, though not of practical importance, on Fig. 7 are plotted the corresponding figures on a basis price of cobalt at 5*s.* per lb., or 6·25*s.* including losses in melting. In this case it is seen that the addition of cobalt is justified in all cases except the low-alloy steel, and that the figure of merit for the cobalt-steel series rises very nearly to that of a cobalt-free low-alloy steel. When allowance is made for the incidental savings which the cobalt steel would furnish, it is seen that, under practically all conditions, it would be economically superior.

It is clear from the foregoing that if it is merely

desired to obtain the highest value of the ratio $\frac{BH\ max.}{cost}$ or to get the maximum magnetic content for a given outlay, there is no justification with the present price of cobalt in making any use of it, and that a plain alloy steel of the ordinary chromium type represents a much better investment. The fact that, as already indicated, cobalt steels are used in considerable quantities, is due to two factors—firstly, the incidental savings which they frequently make possible due, in general, to the shorter length and simpler form which the magnets take, with consequent reduction in the cost of forming, grinding and hardening, and secondly to the fact that, in many cases, they render possible the achievement of certain results which would otherwise be difficult or impossible. As examples we may cite the production of magnetos with revolving field magnets, the design of very light and compact revolving-field alternators for aeroplane service, and the provision of the necessary field for loud speakers, of the suspended-coil type.

It is not possible, of course, to give any general principles which can be made to cover the reduction in labour and attendant charges which can be effected by the use of the cobalt steels, and each case must really be left for consideration on its merits. The foregoing figures do, however, indicate that with the present price of cobalt no widespread supercession of the ordinary tungsten or chrome steels by steels of the cobalt type can be expected, and that their use must be confined to exceptional cases where the incidental savings will more than offset the increased cost of magnetic material. Should it, however, be possible in the future to obtain adequate supplies of cobalt in the neighbourhood of 5*s.* to 6*s.* per lb. then one may say, with certainty, that there would be no justification for the present tungsten and chrome steels to continue their existence.

In conclusion, the author would acknowledge his indebtedness to Messrs. M. L. Magneto Syndicate, Limited, in whose laboratory much of the experimental work has been carried out. Also to the numerous steel makers who have supplied steel and information, and particularly to Mr. I. F. Kayser of the Cobalt Magnet Steel Company, to Mr. J. W. Naylor of Steel (Sheffield), Limited, and to Mr. Geo. Vickers, of Vickers, Limited.

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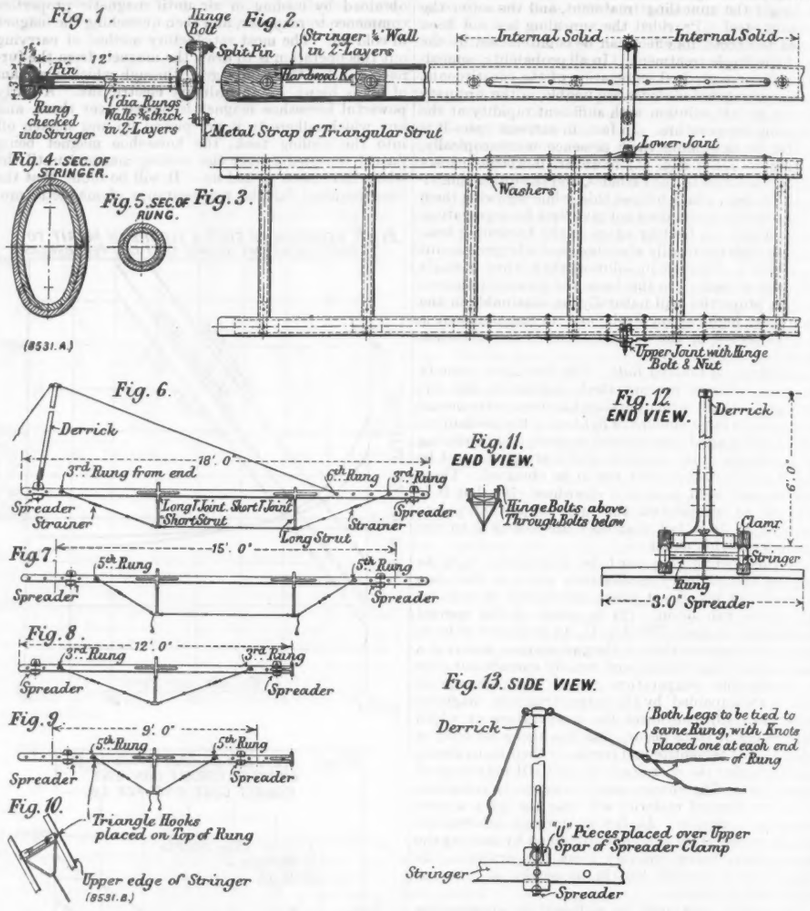
Bolton Steel Works to Close.—The Bolton works of Messrs. H. Bessemer and Company, Limited, have been acquired by Messrs. Thos. W. Ward, Limited, the well-known iron, steel and engineering firm of Sheffield. The works, which are expected to be dismantled and sold, comprise Siemens' furnaces, steam hammers and forge equipment, rolling mills, locomotives, cranes, railway sidings, machine tools, axle and pattern shop equipment, &c.

Amalgamations in the German Electrical Industry.—A number of firms in the electro-technical industry in Germany have recently joined together to form a new share company under the name of Elektrowerke A.G., Duesseldorf. The share capital at present amounts to 100,000 gold marks, of which 80,000 marks are ordinary shares, the rest being preference shares. The firms concerned in the amalgamation are: Berlinische Elektrizitaetsgesellschaft Gebr. Nolzen, of Rousdorf; the Stolper Elektromotorenfabrik Heinz Ziegler, of Stolp, Pomerania; the Wilma Elektromotorenfabrik of Merkendorf; the Widerstands-Baugesellschaft, G.m.b.H., Bonn; the Gesellschaft fuer Elektrische Industrie, G.m.b.H., Cassel; and Messrs. Karl Schlueter, Elektrische Anlagen, G.m.b.H., of Duesseldorf.

LADDER BRIDGE FOR MOUNT EVEREST EXPEDITION.

CONSTRUCTED BY THE McGRUER HOLLOW SPAR COMPANY, LIMITED, GOSPORT.



LADDER BRIDGE FOR THE MOUNT EVEREST EXPEDITION.

It is now generally realised that the attempt to reach the summit of Mount Everest involves the severest possible test of human endurance, even with the aid of modern scientific and mechanical appliances; without them the chances of success would be but slight. The 1924 expedition, it will be remembered, has recently been abandoned after the loss of Messrs. Leigh-Mallory and Irvine, who were pushing on alone, equipped, of course, with oxygen-breathing apparatus, and were last seen when within about 1,000 ft. of the summit. What accident befell them, and whether or not they actually reached the summit, are at present matters for conjecture only. Their loss when so near to the full attainment of the object of the expedition, however, will be deeply regretted by all who can appreciate the degree of courage and endurance necessary to overcome the natural obstacles to success.

In previous expeditions difficulties had been experienced in the later stages of the climb owing to the existence of crevasses at an altitude of about 24,000 ft. In planning the 1924 expedition, therefore, the Committee decided to include in the equipment a light portable structure which could be used as a bridge for crossing crevasses, and might also be employed in an upright position as a ladder. The maximum span to be provided for was about 18 ft., and the strength had, of course, to be sufficient to carry a fully-equipped climber. For transport purposes, it was necessary to limit the maximum length of the dismantled structure to about 6 ft., and the weights allowed were limited to 40 lb. for a porter and 80 lb. for a mule. To comply with these conditions, the ladder bridge illustrated in the accompanying engravings was designed by Mr. J. McLintock, the works manager of the McGruer Hollow Spar Company, Limited, in consultation with Mr. P. J. H. Unna, the engineer to the expedition, and was constructed at the McGruer Company's works, at Beach-street, Gosport.

The McGruer system of hollow timber construction was originally introduced for the masts, booms and spars of yachts, but it has since been applied to aircraft construction and to other uses in which lightness combined with great strength to resist bending moment and compressive stresses are important considerations. Almost any form of straight or curved taper can be made with circular, elliptical or pear-shaped sections. The wood employed is Pacific Coast spruce, mainly because of its even growth, and boards of any thickness between 0·1 in. and 0·4 in. are bent breadthwise and the edges made to meet in a scarf joint which is glued with a waterproof glue. Two or more layers of wood may be employed, glue being used between the layers, as well as at the joints, but no attempt is made to cross the fibres which are all arranged to lie parallel with the length of the member.

The construction of the ladder bridge we are now considering is illustrated in Figs. 1, 2 and 3, and sections of the stringers and rungs are given in Figs. 4 and 5, respectively. The stringers, it will be seen, are of hollow elliptical section and are composed of two layers having a total thickness of $\frac{1}{4}$ in.; the external dimensions of the stringers are 3 in. by $1\frac{5}{8}$ in. The rungs are of circular section, 1 in. in diameter, with a wall thickness of $\frac{1}{8}$ in., and are also built up of two layers; the method of fixing them to the stringers will be clear from an examination of Figs. 1, 2 and 3. The ladder is made in three sections, of which the centre section is 6 ft. $1\frac{1}{2}$ in. in length, while the two end sections are each 5 ft. $11\frac{1}{4}$ in. long. The sections are connected, as shown, by "T" hinges secured by plain bolts below the ladder and by hinged bolts above it. Triangular struts of hardwood are secured to each hinge by metal straps to support the bracing, which consists of steel aero wires fitted with strainers and provided with triangular hooks at each end which fit on to the rungs. The arrangements of the bracing for spans of different lengths are illustrated in Figs. 6 to 9, while Fig. 10 shows the form of the end hooks and the method of attaching them to the rungs; and end view of the ladder showing one of the triangular bracing struts is given in Fig. 11.

To distribute the load more uniformly on the

HIGH-SPEED STEAM ENGINE AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. BROWETT, LINDLEY AND CO., LIMITED, ENGINEERS, MANCHESTER.

Fig. 1.

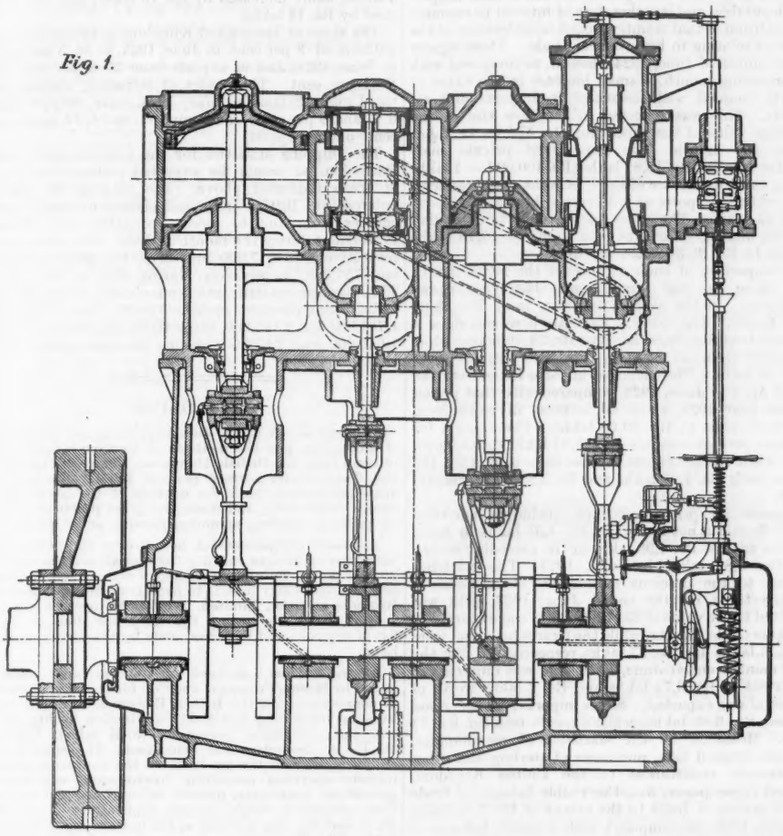
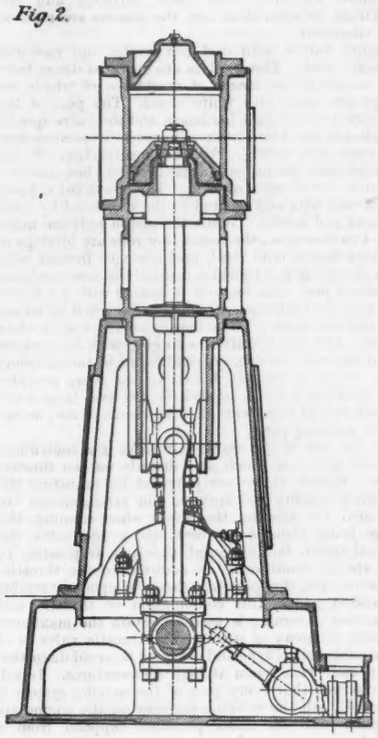


Fig. 2.



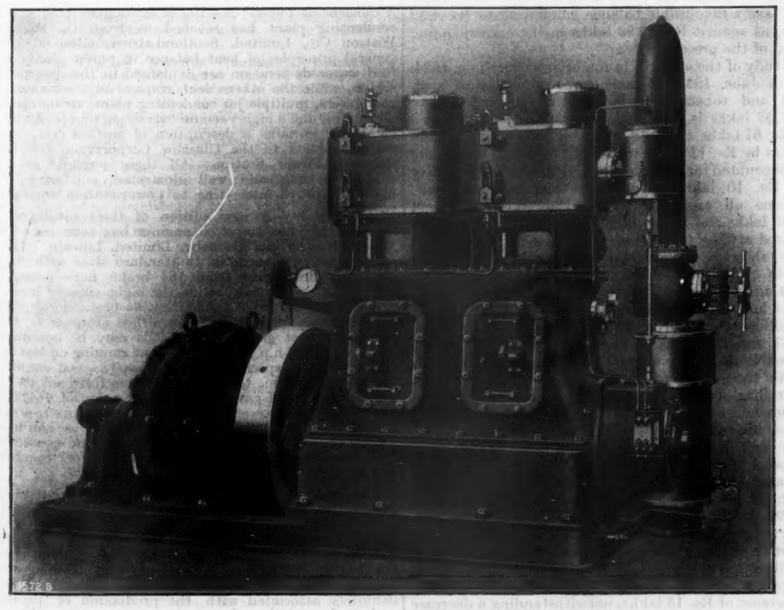


FIG. 3. ENGINE FITTED WITH THROTTLE GOVERNING ONLY.

uneven surface of the snow or ice upon which the structure might rest, an adjustable spreader made of hollow spar was fitted at each end, and to facilitate the operation of lowering the bridge over a chasm, a derrick, also made of hollow spar, was provided. The derrick is attached to the clamps of one of the spreaders, as shown in Figs. 12 and 13, while the arrangement of the guy ropes is illustrated in Fig. 6.

The structure was carefully tested before despatch, and, with a span of 16 ft. 6 in. between the spreaders, the deflection amounted to 1½ in. with a concentrated load of 274 lb. placed at the centre. The total weight of the complete ladder bridge is 45 lb. 13 oz., to which must be added the weight of the derrick and its attachments amounting to 4 lb. 15 oz. The whole of the equipment was carried in a packing case weighing 36 lb. 12 oz., so that the total load to be carried was 87½ lb.

BROWETT-LINDLEY HIGH-SPEED STEAM ENGINE.

ESSENTIALLY a British development, the high speed enclosed type of steam engine was originally introduced for direct coupling to electric generators. The great problem which confronted the pioneers in this phase of engineering design was the provision of effective lubrication for the moving parts. The methods which had been used previously for lubrication of slow running engines proved unsatisfactory for the new conditions. The designers were, however, encouraged in their quest for a suitable system by the knowledge that if a solution to the problem was obtained more rapid development of the electrical industry would become immediately possible, and especially in the country where the first engines embodying the new provisions were produced. In the accompanying illustrations, Figs. 1 and 2, are shown the details of construction of an engine of this type made by Messrs. Browett, Lindley and Co., Limited, of Sandon Works, Patricroft, Manchester, which runs at 500 r.p.m. to 550 r.p.m., and is suitable for direct coupling to a dynamo of 100 kw. capacity. In Fig. 3 is shown a general view of a high-speed steam engine of similar design generally, but embodying some slight modifications. An engine of this type forms part of the firm's exhibit in the Palace of Engineering of the British Empire Exhibition.

From Figs. 1 and 2 the construction of this two-cylinder two-crank engine can be seen. It will be noted that each cylinder and its valve chest are cast together and that their form is simple in order that no distortion may be caused through unequal stresses due to high temperature actions. Each cylinder and valve chest casting is mounted on a cast-iron distance piece, the extension of which forms a bored guide for the crosshead slippers. Leakage into this part of the

structure from the piston rod glands is collected and led by pipes inside the frame to a small tank which is formed in the engine bed. Here provision is made for the automatic separation of oil from the water. The oil is passed to the crank chamber and the water to a drain. The top and bottom covers are accurately machined all over their inner surfaces, and the clearances between them and the pistons are reduced to a minimum.

Piston valves with cast-iron bodies and cast-iron rings are used. These valves are operated direct from the crankshaft by means of eccentrics, of which the straps are lined with white metal. The pins of the eccentric rods are case hardened, and the valve spindle crossheads are fitted with adjustable brasses secured by caps and bolts. For the construction of the high-pressure piston cast iron is used, but the low pressure one is made of steel. The crosshead slippers are of cast iron and secured to the crosshead by solid feathers and screws. While the piston rods are made of 0·4 carbon steel, the connecting rods are forgings of Siemens-Martin mild steel, and are each formed with jaws at the top end to which is fitted the case-hardened crosshead pin. The big end is formed with a flat foot to which the bushes are attached and secured by means of a cap and bolts. These bushes are lined with white metal. The crank-shaft is a forging with two cranks at an angle of 180 deg. A rigid frame of the enclosing type, which is securely bolted to the base, provides four bearings for the crankshaft and two large doors in each side of this frame give the means of easy access to the working parts.

At the end of the crankshaft there is a centrifugal type of governor which acts directly on the throttle valve. Simple means are provided for adjusting the governor weights and springs, and arrangements are provided for altering the speed when running, the range being about 5 per cent. above and below the normal speed, but increased provision is possible to suit special conditions. In addition to the throttle-valve control, the governor also acts upon a variable expansion gear. This combination of throttle and expansion governing is used to obtain the maximum possible economy of steam. The throttle valve is of the double seated type and designed to avoid distortion when used with steam at high temperatures. It will be observed that every part of the moving system is enclosed. All the working surfaces on the engine are supplied with oil under pressure, supplied from a valveless pump placed in an easily accessible position in the lower part of the bed and actuated from one of the main eccentrics. This and the connecting pipe system are clearly indicated in Figs. 1 and 2. Effective lagging of the cylinders and covers is ensured by the use of a thick layer of magnesia composition within planished steel casings.

Fig. 3 shows a complete engine generator set with the flywheel between the two components. In this engine, the variable expansion gear shown in the drawings has been omitted, but otherwise it is of similar construction. Single, compound and triple expansion engines, with both systems of governing are made by the firm in a variety of standard sizes ranging from 4 brake horse-power up to 2,500 brake horse-power.

The Mineral Industries of Canada.—As is well known, Canada has been lavishly provided by nature with valuable minerals, some of which are not found in corresponding profusion anywhere else. In a former issue we drew attention to the remarkable display made by her at Wembley. Further particulars as to her mines and reduction works will be found in the official report on "The Mineral Industries of Canada," which has just been printed by the Mines Branch of the Department of Mines, Ottawa. The annual value of the mining and metallurgical products of this great Dominion, which was but 10,250,000 dols. in 1886, was no less than 227,859,665 dols. in 1920. Canada stands first in the production of asbestos, nickel and cobalt. Her coal resources, moreover, are exceeded only by those of the United States and of China.

A Large Building Girder.—What is said to be the largest girder in building construction in the world has recently been installed in the new Consistory building in Buffalo, New York. The girder weighs a hundred tons and is a little over a hundred feet long. When the building is completed it will support the weight of the entire balcony of the auditorium, which will seat 1,000 people, and the load carried, when the balcony is filled, will be 1,100,000 lb. The girder rests on two special columns at the sides of the building, and its use means not only a great saving in space on the floor of the auditorium (as there will be no pillars or other obstructions in the way of the audience) but also a greatly increased factor of safety. The girder was constructed by the Buffalo Structural Steel Company. It was built in six sections, and transported to its location by means of trucks with trailers, and assembled on the site. At the centre, where it is heaviest, the girder has five cover plates, each 36 in. by ½ in., thinning down to two cover plates at each end. The whole girder is 100 ft. 8 in. long, 7 ft. deep at the centre and 3 ft. wide.

INDIAN OVERSEAS TRADE.

That the prosperity of India is of the utmost importance to the economic position of the British Empire is indisputable, and it is therefore of interest to examine the condition of that country from a consideration of the statistics relating to her overseas trade. These figures for the month of June, 1924, showed, as compared with the preceding month, a small increase in the value of exports coupled with decreases in imports and re-exports. This was reflected in the slow rise of the exchange value of the rupee from 1*s.* 4$\frac{1}{16}$*d.* to 1*s.* 5$\frac{1}{16}$*d.* during the month. The imports of private merchandise totalled Rs. 18,82 lakhs (Rs. 100,000 = 1 lakh) during June, a decrease of Rs. 1,78 lakhs compared with May, while re-exports also decreased by Rs. 7 lakhs to Rs. 1,25 lakhs. The value of the exports of Indian produce and manufactures rose from Rs. 27,73 lakhs in May to Rs. 28,36 lakhs in June.

A comparison of trade figures for the latter month with those for the same month last year shows an increase, in the case of imports, from Rs. 18,01 lakhs to Rs. 18,82 lakhs. Exports, however, show a decrease from Rs. 28,60 lakhs to Rs. 28,36 lakhs, while re-exports show an increase from Rs. 1,21 lakhs to Rs. 1,25 lakhs. The inclusive imports taken over the period April to June, 1923, compared with that period for the year 1924, show an increase in value from Rs. 58,29 lakhs to Rs. 59,69 lakhs. The exports for the same periods compare Rs. 86,61 lakhs to Rs.85,53, lakhs, while the re-exports likewise show a decrease, the figures being Rs. 4,05 lakhs and Rs. 3,82 lakhs, respectively.

Treasure on private account, including currency notes, showed a net import of Rs. 4,31 lakhs in June, 1924, as against Rs. 4,99 lakhs in the preceding month and Rs. 3,82 lakhs in June, 1923. The statistics relating to the precious metals are of importance. For the three months ended June, 1923, gold was imported to the value of Rs. 12,06 lakhs and exported to the value of Rs. 2 lakhs, while the figures for silver, were Rs. 4,53 lakhs and Rs. 37 lakhs, respectively. For the three months ended June, 1924, gold was imported to the extent of Rs. 8,78 lakhs and Rs. 2 lakhs worth of the metal was exported. Silver imports for this period reached Rs. 6,80 lakhs, while exports totalled Rs. 73 lakhs. Measured by the statistics of merchandise, treasure, council bills, purchases of sterling and other Government remittances to the United Kingdom, enfaced rupee paper, &c., the visible balance of trade was in favour of India to the extent of Rs. 3,67 lakhs in June, 1924, as compared with a credit balance of Rs. 2,50 lakhs in May, 1924, and of Rs. 6,79 lakhs a year ago. During the three months ended June, 1924, there was a favourable balance amounting to Rs. 4,32 lakhs, as against Rs. 15,93 lakhs in the corresponding period of the preceding year.

A study of the changes in imports during June, 1924, and in June, 1923, is instructive. Relative to food, drink and tobacco, an increase of Rs. 5 lakhs to Rs. 1,53 lakhs is apparent. Raw materials increased by Rs. 67 lakhs to Rs. 2,27 lakhs, and manufactured articles by Rs. 11 lakhs to Rs. 14,77 lakhs. Imports of salt accounted for an increase of 36,000 tons in quantity and Rs. 10 lakhs in value. Under raw materials, kerosene oil and raw cotton showed increases of Rs. 40 lakhs and Rs. 24 lakhs, respectively. Of manufactured articles the imports of cotton, yarn and piece goods showed a considerable increase. Grey goods rose in quantity from 48 million yards to 65 million yards and in value by Rs. 69 lakhs to Rs. 2,22 lakhs. White and coloured goods also rose by 6 million and 2 million yards in quantity, respectively, and by Rs. 37 and 22$\frac{1}{2}$ lakhs in value. There were, however, noticeable decreases under machinery, including belting, to the extent of Rs. 74 lakhs. Railway plant and rolling-stock fell by Rs. 50 lakhs and electrical instruments by Rs. 1,4 lakhs in value, respectively.

The value of the exports of Indian merchandise, food, drink and tobacco, as compared with June, 1923, increased by Rs. 18 lakhs to Rs. 7,73 lakhs, due to an increase in the exports of foodgrains of Rs. 1,05 lakhs, which, however, was partly offset by a decrease of Rs. 96 lakhs in tea. Raw materials and produce exported decreased by Rs. 1,71 lakhs to Rs. 13,48 lakhs. Under this group, oil seeds decreased by Rs. 1,10 lakhs, raw hides and skins by Rs. 49 lakhs, lac by Rs. 30 lakhs and raw jute by Rs. 15 lakhs, while raw cotton showed an increase of Rs. 15 lakhs, notwithstanding a decrease of 10,000 tons in quantity. Of the total shipment of 45,000 tons of raw cotton, Japan took 15,900 tons or 35 per cent., China and Italy 9,000 tons or 20 per cent. each, Belgium 3,500 tons, France 2,600 tons, and the United Kingdom 1,800 tons. Exports of raw jute decreased in quantity from 21,200 tons to 18,700 tons, and in value from Rs. 78 lakhs to Rs. 63 lakhs. Manufactured goods rose by Rs. 1,10 lakhs to Rs. 6,85 lakhs. The shipments of gunny bags in June, 1924, fell from 28 millions, valued at Rs. 1,30 lakhs, to 23 millions, valued at Rs. 1,21 lakhs. The yardage of gunny cloth exported rose from 89 millions, valued at Rs. 2,01 lakhs, to 141 millions, valued at Rs. 2,45 lakhs. Other noticeable increases, to the extent of Rs. 18 lakhs, were under cotton yarns and manufactures. Tanned skins increased by Rs. 19 lakhs, and iron and steel by Rs. 14 lakhs.

The share of the United Kingdom in Indian imports fell from 61·3 per cent. in June, 1923, to 56·5 per cent. in June, 1924, and in exports from 27·8 per cent. to 19·4 per cent. The shares of Germany, Japan and the United States in June, 1924, were, respectively, 6, 7, and 9 per cent. under imports, and 4, 17, and 9 per cent. under exports.

The shipping statistics for the periods under consideration, as would be expected, reflect the state of trade indicated above. The tonnage of vessels entered into British India and cleared outwards with cargoes from and to foreign countries and British Possessions during the month of June, 1924, amounted, respectively, to 517,000 and 683,000, against 581,000 and 752,000, respectively, during May of this year. The tonnage entered into and cleared from British India during the three months April to June, 1924, was 1,701,000 and 2,118,000, respectively, as compared with 1,636,000 and 2,076,000 during the same period last year.

CATALOGUES.

Aluminium.—A useful little booklet on the properties of aluminium and the methods of working it, has come to hand from the British Aluminium Company, Limited, 109, Queen Victoria-street, London, E.C.4. The booklet deals particularly with the working of the metal from sheets, coiled strip, and discs, and gives practical advice on pressing, beating, spinning, jointing and finishing.

Automatic Telephones.—A list of over 100 automatic telephone exchanges ranging from small private sets of 15 lines to the Edinburgh exchange with an initial capacity of over 14,000 lines, is to hand from Messrs. Siemens Brothers and Co., Limited, Woolwich, together with a shaped folder illustrating the telephone dial. A new list of dry cells and batteries made by the firm is also to hand.

Electrical Plant.—A book of 120 pp. large octavo, issued by Messrs. Crompton and Co., Limited, Chelmsford, in connection with the British Empire Exhibition, contains an interesting historical introduction dealing with the early electrical inventions with which Colonel R. E. B. Crompton was associated. The subsequent chapters refer to the products of the company, which include electrical measuring instruments, switchgear, generators, converters, motors, ceiling fans, and search-light projectors, while various applications of electric drive and the firm's works at Chelmsford are also dealt with. The illustrations are numerous and clear and the printing and binding excellent.

Condensing Plant.—A series of catalogues dealing with condensing plant has reached us from the Mirrlees, Watson Co., Limited, Scotland-street, Glasgow. The general principles of heat balance in power plants and feed water de-aeration are explained in the first publication, while the others deal, respectively, with surface condensers, multiple jet condensing plant, steam ejector air pumps, and a high-vacuum extraction pump. Another catalogue contains a description of surface condensing plant supplied to the Glasgow Corporation for Dalmarnock Power Station. All these publications are clearly written and well illustrated, and they will doubtless prove interesting to power-station engineers.

Oil Engines.—A new edition of their catalogue of cold-starting, horizontal oil engines has been issued by Messrs. Ruston and Hornsby, Limited, Lincoln. These engines are now made in 13 standard sizes with single cylinders, developing from 16$\frac{1}{2}$ brake horse-power to 170 brake horse-power, while the eight sizes of double-cylinder engines listed range from 84 brake horse-power to 340 brake horse-power. An airless atomiser is used, and the lowest grades of fuel oils may be consumed. A test of the 38-h.p. to 42-h.p. engine running on Mexican fuel oil of 0·950 specific gravity, showed a speed variation of only 250 r.p.m. to 252 r.p.m. from full load to one quarter load, and gave a fuel consumption of 0·422 lb. per brake horse-power hour at full load, rising to 0·425 lb. at three-quarter load, and 0·455 lb. at half-load. The engines are suitable for driving electric generators or factory line shafting, and for any other work requiring steady running.

Iron and Steel Plant and Products.—We have received a copy of a handsomely printed book from Messrs. Newton, Chambers and Co., Limited, Thorncliffe, near Sheffield, describing their works and plant and illustrating the character of their products. The products may roughly be divided into two classes: one including coal, iron-ore, coke, pig iron and the chemical products now definitely associated with the production of pig-iron and steel; and the other, castings, constructional steel, tanks, pipes, and the general heavy plant required in the production of the first-named class. Amongst this plant we notice, for instance, complete blast furnace and gas-making equipments, a 500-ton tilting furnace, a 500-ton metal mixer, an 80-ton metal ladle, a pit-head pulley wheel 24 ft. in diameter, large gas valves, hammer blocks of 50 tons and 70 tons weight, an engine crank-case weighing 30 tons, tunnel segments in cast-iron, the frame of a steel building 400 ft. by 165 ft. in plan and 35 ft. high, which was erected in place in three weeks, and finally small cast-iron heating boilers and a full range of pipes, gutters, &c., for conducting rain water from buildings.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

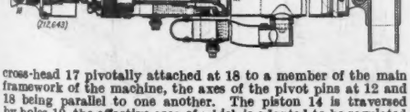
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

AERONAUTICS.

212,344. Armstrong-Siddeley Motors, Limited, Coventry, and H. N. Wylie, Coventry. Metallic Aircraft Construction. (3 *Figs.*) December 28, 1922.—The invention relates to the construction of metal members or structures for use on aircraft, and it has for its object to provide an improved and simple method of forming a tubular channel, or other suitable structure, of sheet or strip metal with a longitudinal joint. According to the invention, each edge of the sheet is flanged and the outer edge of each flange is turned outwards so that the two flanges when back to back form a "T." An embracing strip is then threaded upon the flanges and is crushed in a direction across its width, upon the oppositely turned edges of the flanges, thus tending to close the split edges together and permanently deforming it so that it retains its grip when the externally applied pressure is removed. The edges of the sheets A and B are flanged in the manner shown, the parts A^2, B^2 approximately perpendicularly to the sheets and the parts A^3, B^3 substantially at right angles to the parts A^2, B^2, and opposite to one another in the manner shown. The sheets are next positioned so that the flanges A^2 and B^2 are brought into contact

and the parts A^2, B^2, A^3, and B^3 form a "T" in the manner illustrated. The embracing strip C, preferably of hard springy metal, is bent so that its cross-section resembles a chain link having a gap in one straight side or a flattened ring split along one of its flattened sides, the size of the cross-section being such that it closely, but with sliding clearance, embraces the outward flanged edges A^2 and B^2. The embracing strip is first slipped along the flanges into place and then pressed between a pair of rollers placed parallel to the width of the strips C, one on each side thereof, and having a gap of roughly the same shape as the embracing strip C, but shallower. Hence the embracing strip is completely contained in the gap between the rollers, and has its cross-section crushed to smaller dimensions, the bight of the strip (indicated at C^2) being forced upon the outwardly turned edges of the flanges. During this process the thickness of the strip may be increased by the crushing action if the reduction in other dimensions is very great. Furthermore, the crushing action is so effective that, notwithstanding initial springiness of the material, the strip permanently retains a close grip of the flanged parts.—(*Sealed.*)

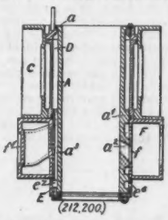
212,643. The Fairey Aviation Company, Limited, Hayes, Middlesex, and C. R. Fairey, Hayes, Middlesex. Shock-Absorbers. (1 *Fig.*) December 14, 1922.—The invention relates to shock absorbers of the fluid dash-pot type, more particularly those commonly applied to the chassis of aeroplanes. According to the invention, the only communication between the opposite ends of the dash-pot cylinder is by way of apertures in the piston, the effective area and/or the number of the apertures being controlled by means of a valve adapted for being adjusted either automatically or at will. The cylinder is pivotally attached at 12 to a member 13 of the wheel-chassis of an aeroplane. A piston 14 is fixed on the end of a tubular piston-rod 15, which, passing out of the cylinder by way of a stuffing-box 16, is made fast to a non-rotatable



cross-head 17 pivotally attached at 18 to a member of the main framework of the machine, the axes of the pivot pins at 12 and 18 being parallel to one another. The piston 14 is traversed by holes 19, the effective area of which is adapted to be regulated by means of a rotary valve 20 in contact with the underside of the piston, and having corresponding holes 21 adapted to register more or less with the holes 19 in accordance with the angular position of the valve relatively to the piston. The valve 20 is fixed on the lower end of an inner piston-rod 22 which, traversing the entire length of the tubular piston-rod 15 and projecting above the upper extremity of the latter, carries at its upper end a radial arm 23 by means of which this inner piston-rod 22 can be turned about its axis, by means not illustrated, through the required angle.—(*Sealed.*)

GAS ENGINES, PRODUCERS HOLDERS, &c.

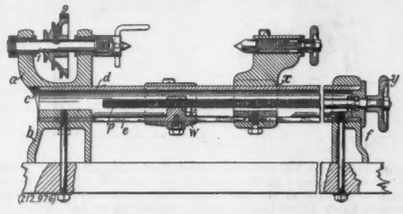
212,200. Swan, Hunter & Wigham Richardson, Limited, Walker, Newcastle-on-Tyne, F. Rowntree, Monkseaton, and P. Belyanin, Jesmond, Newcastle-on-Tyne. Cylinders. (3 *Figs.*) November 2, 1923.—The invention relates to cylinders and cylinder liners for two-cycle internal combustion engines. According to the invention, the lower end of the liner is provided with a ring fitted around it and forming with the liner an inlet and distributing channel for the cooling water, which is distributed from the channel to vertical passages in the liner wall leading to the cylinder water jacket. A is the cylinder liner having a top flange *a* by which it is secured to the cylinder cover. The lower flange a^1 of the liner has the usual ports, the scavenging port a^2 being shown at one side. C is the entablature supporting the cylinders. D is the cylinder jacket. E is the ring fitted over the lower end of the liner A and bolted to the bottom flange of the liner. The cooling water is introduced through the hole e^6 in the ring E and enters the distributing channel e^7. The entablature C carries the box F through which the lower part of the liner A passes, making a sliding joint which allows the liner to expand and contract axially, the box



F being provided with the inlet port *f* and exhaust port f^1. The ring E is of plain flanged form and the water channel e^7 is formed entirely in the bottom flange of the liner A, and the vertical passages a^3 leading to the cylinder water jacket open directly into the channel e^7.—(*Sealed.*)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

212,976. F. R. Wade, London, and C. A. V. Small Tools, Limited, Hove. Turning-Lathes. (7 *Figs.*) December 18, 1922.—The invention relates to small lathes, such as model makers' lathes. The headstock *a* and pedestal *b* are made in one piece, the pedestal *b* being hollow with a wide base and sides sloping upwards towards a central bellied portion *c* adapted to receive the tubular bed *d* furnished with a slot *e*. The pedestal *f* at the tailstock end is similarly formed hollow and with a bellied



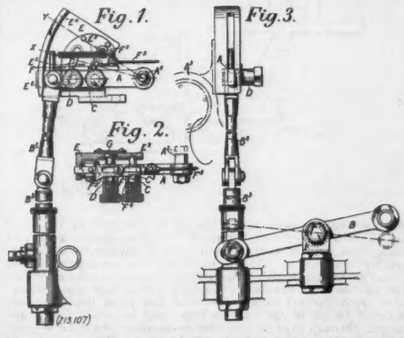
portion. The tubular bed *d* fits into the holes in the bellied portions of the pedestals *b* and *f*. The feed-screw *p* has a hand-wheel *y* fixed to one end thereof, and near the hand-wheel the screw is left plain to form a journal. The screw *p* and its bearing are inserted together in the end of the hollow bed and the screw is screwed into the nut *v* of the saddle *w*, after the saddle and the tailstock *x* are in position. The mandril is furnished as usual with a coned pulley 9 and a driving chuck with centre.—(*Sealed.*)

MOTOR ROAD VEHICLES.

213,107. S. L. Bailey, Bristol. Change-Speed Gear-Operating Mechanism. (3 *Figs.*) March 16, 1923.—The invention relates to change-speed gear-operating mechanism for motor cycles of the kind in which the gear changing is effected by foot-controlled mechanism, and in which, to avoid overrunning an intermediate gear position, a movable plunger is provided to engage the gear lever or a part connected therewith, thereby to limit its travel from either end of its quadrant to the required position, this plunger being actuated by hand-controlled mechanism to put it out of action at will, and thus permit the gear-control lever to be moved beyond the intermediate position so as to engage the next gear. According to the invention, the plunger is mounted upon a movable part (preferably a lever of the gear-change mechanism), and is adapted to engage a peg which is free to travel along a slot provided upon a fixed plate or bracket and of such length that, from either end of its travel, the gear lever is brought to the exact position required. The arm A on the stem A^2, which enters the gear-box A^3 and carries the striking fork (not shown), is connected by a hinged link B^2 and guided plunger B^3 with the pivoted foot lever B. By moving this lever B,

Fig. 1. *Fig. 3.*

Fig. 2.



the arm A can be moved into three positions about the stem A^2 providing three changes of gear. The arm A carries a pair of transversely sliding plungers C and D, of which C is the locating plunger and is adapted to engage one of three holes E^2 in a plate E when the arm is in its respective "in gear" positions. The end of this plunger C is coned, so that it can easily drop into the holes in the plate. To withdraw the plunger, there is provided upon the arm A a sliding cam plate F which is moved in one direction by a spring F^2 and is drawn in the opposite direction by Bowden mechanism F^3, the lever of which is preferably on the handlebar. The cam face F^4 is adapted to engage a peg C^3 on the plunger C, and the arrangement is such that, when the hand lever is moved only a small distance, the cam lifts the plunger, allowing the arm A to be moved and the gear to be changed. The second plunger D is also engaged by a cam face F^5 on the plate F; this cam face is so shaped and set that it only comes into operation when the hand lever is fully moved, and this plunger engages the travelling stop. The travelling stop takes the form of a peg G, which lies in a slot E^3 in the plate E. The slot is curved in accordance with the curved path of the plunger D, which is adapted to engage the peg upon either side (that is, above or below it in the drawing) and thereby the movement of the lever is limited through contact of the peg G with the ends of the slot. Assuming the travelling stop to be above the plunger D and in engagement with it, provided the plunger C is first disengaged, the arm A is then free to move from its lowest position only so far as its intermediate position, indicated by the dotted line X, the travelling stop then coming into contact with the upper end of the slot E^3. Thus the rider's foot can be safely employed to move the sliding gears to effect the change of gear involved by this movement of the arm A, and there will be no danger of over-shooting the position because this is wholly prevented by contact of the travelling stop with the end of its slot. Now, if it is required to move the arm A to to get the gear corresponding to its highest position, as indicated by the dotted line Y, it is only necessary to withdraw the plunger D from engagement with the travelling stop G, and the movement of the arm A can be again effected as before by the rider's foot, the arm at the end of its travel coming into contact with the usual stop E^4 provided for the purpose on the bracket E. If now the movement of the arm A is to be from the position Y to the position X, it will be observed that the plunger D is now upon the upper side of the stop G, and, as a consequence, contact of the latter with the lower end of its slot E^3 will prevent the arm A moving below the intermediate position indicated at X, and the operation can, as before, be effected with perfect safety by the rider's foot. By withdrawing the plunger D, the remainder of the downward movement of the arm can be effected to obtain the gear corresponding to the lowest position of the arm, as shown in the drawings, where the usual stop E^5 checks further movement. It will now be obvious that to cause the arm A to travel in one sweep the whole distance from the top to the bottom, or *vice versa*, thereby to skip the middle gear position, it is only necessary wholly to withdraw the plunger D from contact with the travelling stop. Such an effect, therefore, is obtained by moving the hand lever to its full extent, so that both the plungers C and D are withdrawn during the operation, whereas if the middle gear is to be engaged either in the up or the down movement of the arm A, the hand lever is operated only sufficiently to retract the plunger C. (*Sealed.*)

212,955. Walker Brothers (Wigan), Limited, Wigan, and W. D. Williamson, Wigan. Motor Road Vehicles. (4 *Figs.*) October 30, 1922.—The invention relates to six-wheeled vehicles of the type wherein a two-wheeled attachment is adapted to be supported at the end opposite that supported by the wheels by means of a turntable carried by another vehicle. According to the invention, the attachment is provided with a tipping body, tipping about a horizontal axis and adapted to be operated in any position of rotation of the attachment about the axis of the turntable. The vehicle 1 is carried by a frame 2 and wheels 3, and is adapted to support the forward end of an attachment body 4, the rear portion of which is carried on wheels 5 mounted on a chassis 6. The attachment body 4 is carried by a sub-frame 7 and is mounted to rotate about a horizontal axis at the rear end relatively to the sub-frame. At the forward end of the vehicle, on the frame 2, is mounted one portion 8 of a turntable, the other portion 9 of the turntable being mounted on the sub-frame 7.

Fig. 1.

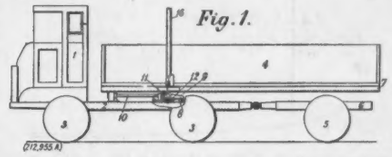
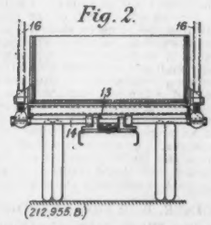


Fig. 2.



The attachment body 4 is therefore capable of rotation about the vertical axis of the turntable. The vehicle is provided with means for tipping the attachment body 4, adapted to be driven from the supporting vehicle 1, and to this end a shaft 10 is mounted on the frame 2 and is adapted to be connected by a clutch with the driving shaft of the engine. The shaft 10 is so arranged that its axis intersects the vertical axis of the turntable 8, 9. The shaft 10 is provided at its rear end with a bevel wheel 11 adapted to engage with a corresponding bevel 12 mounted concentrically with the portion 9 of the turntable. Meshing with the bevel 12 is a further bevel 13 rigidly mounted on a transverse shaft 14. Rotation of the shaft 10 transmits rotary movement to the shaft 14, and, owing to its position, the bevel 11 will engage the bevel 12 whatever the position of the sub-frame 7 and body 4 relatively to the frame 2. At each end of the shaft 14 is mounted a threaded shaft 16 rotated by the shaft 14. Mounted on the threaded shaft 16 is an internally-threaded collar carrying trunnions, and the body 4 is connected to the collar. (*Sealed.*)

PUMPS.

212,966. L. Ward, Chalk Farm, London. Pumps. (5 *Figs.*) December 15, 1922.—The invention refers mainly to the construction of pumps for compressing, exhausting and moving air and gases of the type in which a plurality of pump units is arranged radially in a casing, the pistons of the pumps being operated by a central cam mechanism against the action of helical springs. According to the invention, the pump unit, or units, is, or are, self-contained and each comprises a cylinder, a spring-returned piston, inlet and exhaust valves and parts associated therewith and externally arranged, each pump unit with its inlet and exhaust valves being detachably arranged in a main casing so that the, or each, unit can be removed as a whole, and when more than one unit is employed the removal of any one unit will not interfere with the functioning of the other unit or units. The improved air compressor comprises a multiple unit casing *a* bolted to an electric motor *b* and having one, or a plurality, of openings *c* in which pump units *d* are detachably secured in place. Each pump unit *d* comprises a cylinder, inlet and outlet valves in the head thereof, a piston and a returning spring *i*. Conveniently, each casing unit *a* is provided with four radial openings *c* adapted to receive four cylinders or pump elements *d*. The pistons *f* of these pump elements *d* are fitted at their inner ends with pads *g* adapted to bear against a ball, or roller, bearing *h* mounted on a crank or eccentric portion of the shaft *e* of the driving motor *b*. The pistons *f* are normally kept in towards the ball bearing *h* by means of helical springs *i*

coiled around the outside of the cylinders of the pump elements *d* and bearing on a shoulder *j* provided at the outer end thereof, and on a flange *k* provided on the inner end of the piston *f*.

Fig. 1.

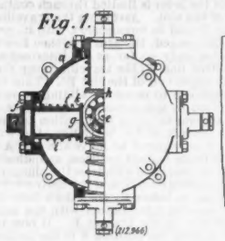
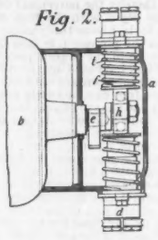


Fig. 2.



The cylinder units *d*, complete with piston *f*, piston pad *g* and spring *i*, are adapted to be inserted from the outside and to be detachably held in place in the bores *c* of their casing *a* by readily-disengageable means. (*Sealed.*)

SHIPS AND NAUTICAL APPLIANCES.

211,927. John I. Thornycroft and Co., Limited, Westminster, London, and Sir J. I. Thornycroft, Bembridge, Isle of Wight. Screw-Propelled Navigable Vessels. (8 *Figs.*) November 23, 1922.—The invention has reference to navigable vessels provided with screw propellers designed for general use as partially-immersed propellers. According to this invention, the screw propeller is arranged with the propeller shaft at such an angle to the centre-line of the vessel that the mean section of each propeller blade, on immersion in the water, will be at right angles to the fore and aft line of the ship so as to drive the water directly astern. The propeller shaft *a* is inclined to the fore and aft centre line of the vessel and the propeller *b* arranged to act as a partially submerged propeller, so that the mean section, indicated by the line *b*1, of the portion thereof that becomes immersed in the water, will, on immersion

Fig. 1.

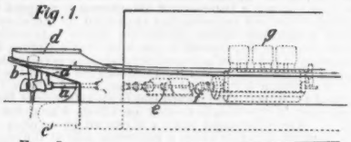
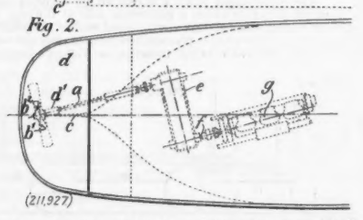


Fig. 2.



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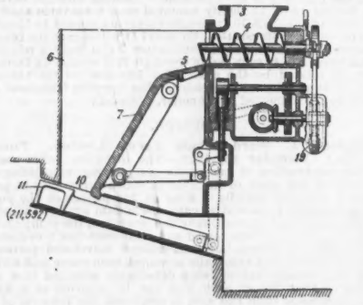
of such portion of the blade, be at right angles, or practically so, to the centre line of the vessel as shown. The line *b*2 indicates the upper blade, for the time being, of the propeller. In the arrangement illustrated, the propeller shaft *a* is so inclined to the centre line of the vessel that its axis intersects the centre line of the vessel behind a centrally pivoted rudder *c*. The outer end of the propeller shaft *a* is supported by a bracket d^1 depending from the overhung counter *d*. In this example, the inner laterally-displaced end of the propeller shaft *a* is driven through belting or toothed gearing, assumed to be confined by a casing *e* having its centre line at right angles to the propeller shaft *a*, and extending at an angle across the centre line of the vessel. The belting, or gearing, is driven from a shaft *f*, which extends forward and across the centre line of the vessel at the same angle as the propeller shaft *a* and is driven by an internal-combustion engine *g* arranged vertically above it. (*Sealed.*)

STEAM ENGINES, BOILERS, EVAPORATORS, &c.

211,592. J. Fallon, Olton. Mechanical Fuel-feed Devices. (2 *Figs.*) November 27, 1922.—The invention consists of a mechanical fuel-feed device for use in combination with furnaces, wherein one side of the furnace is formed as a reciprocating member adapted to be advanced toward and retracted from the opposite wall of the furnace either in parallel planes or in planes radiating from the pivotal support of said member, whereby a feeding and crushing of the fuel within the furnace is effected. The coal is fed through the inlet 3 to a continuous screw 4 by means of which it is delivered over a chute 5 into



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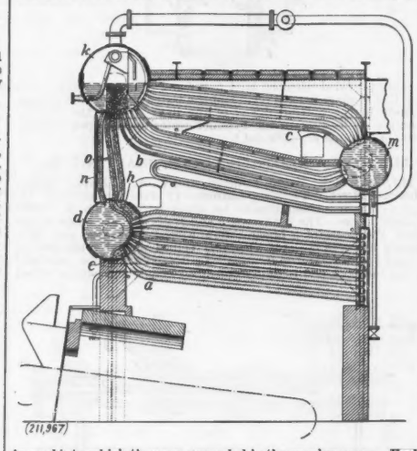
the well of the furnace 6. One of the walls of the furnace 6 is constituted by an inclined bar grate 7 which is hingedly connected at its upper end to the furnace. The grate is connected at its lower end to means designed to impart a defined reciprocal motion thereto. An ash discharge outlet 10 is alternately opened, closed and cleared by means of a reciprocating plough 11. The rotating of the feed screw 4 and the reciprocal motion of the inclined-bar grate 7 and of the plough 11 are effected from a common main driving shaft 19. The reciprocating grate 7 is disposed at such an angle, relative to the opposite or stationary wall of the furnace 6, that the reciprocating motion imparted to the grate 7 can effect a reduction of the size of the clinker or ash by a crushing action in the event of the pieces of clinker being of a larger size than the minimum size of the discharge aperture to the ash channel. (*Sealed.*)

211,967. W. Y. Lewis, Southend-on-Sea, and A. A. Cawkwell, Palmer's Green, London. Water-tube Boilers. (1 *Fig.*) November 11, 1922.—The invention consists broadly in a water-tube boiler, including the combination of "Field" and ordinary water tubes, the former being so disposed as to be swept by the hottest gases and as to shield the latter from the hottest gases. In carrying the invention into effect in the form which is illustrated, three banks of tubes placed one above the other and three steam and water drums are employed. The lower bank *a* constitutes the main evaporating section and consists of "Field" tubes expanded into a water drum *d* disposed horizontally in juxtaposition to the hottest gases of the fire-box. The front ends of the tubes are bent so as to enter radially the



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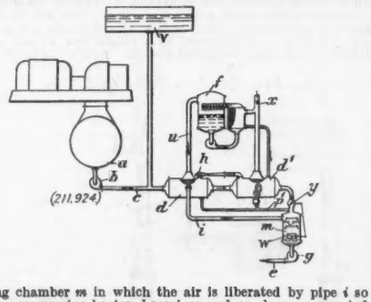
drum *d* into which they are expanded in the usual manner. Each of the inner tubes *c*, at its front end, is connected to a diaphragm plate *h* erected within the drum *d* in sections. The middle bank of tubes *b* forms a secondary evaporating section and a top bank *c* constitutes the economiser section, and for both of these banks plain bent tubes are used, which are expanded at one end into the water space of a steam drum *k* disposed above the drum *d*, and at the other end are expanded into a third drum *m* disposed at the back of the boiler. The nests of tubes *b* and *c* are disposed on the side of the main nest *a* remote from the fire-box so as to be shielded from the hottest gases. Between the drums *d* and *k* a number of short, plain tubes are fitted with their ends expanded into the respective drums, these tubes acting as down-comers *n* and uptakes *o*. (*Sealed.*)

211,924. H. Fothergill, Westminster, London. Steam Power Plants. (1 Fig.) November 22, 1922.—The invention relates to the heating and supply of feed water in steam-power plants. According to the invention, the steam space of the evaporator and the space in the de-aerating chamber in which the air is liberated are directly connected to the evaporator heater by plain pipes or passages. The condensate withdrawn from the main condenser *a* is delivered by a pump *b* by way of a pipe *c* through a surface heater *d*, hereinafter called the evaporator heater, and thence to another heater *d*1, hereinafter called the secondary heater, from which the water passes to the de-aerating chamber *m*. The evaporator heater *d* is maintained under vacuum by an ejector *h* which discharges into the secondary heater *d*1 from which the non-condensible gases pass to the atmosphere. The evaporator heater *d* is connected to the steam space of the evaporator *f* by pipe *u* and to the space in the de-



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aerating chamber *m* in which the air is liberated by pipe *i* so that the evaporator heater *d* receives and condenses generated steam from the evaporator *f* and aerated vapour from the de-aerating chamber *m*. When provided, the secondary heater *d*1 may be supplied with heating steam from the exhaust steam from one or more auxiliaries through pipe *x*, and the drainage water from the evaporator heater *d* and from the secondary heater *d*1, when of the surface type, can be conveniently discharged through pipe *p*1 into the de-aerating chamber *m* from which the de-aerated water is withdrawn by the pump *g* and discharged to the boiler-feed system *s*. The water system on the inlet side of the evaporator heater *d* may be connected to a feed or storage tank *v*, and the de-aerating chamber may be provided with a float *w* which operates a valve *y* controlling the supply of water thereto in accordance with the requirements of the feed system. (*Sealed.*)

TEXTILE MACHINERY.

210,365. David Keay and Leslie, Limited, Dundee, and J. Ness, Springfield. Spinning-Frame Mechanism. (2 *Figs.*) July 20, 1923.—The invention relates to spinning frame mechanism of the kind in which a stirrup is provided for applying pressure to the non-rotatable member of the pressing roller bearing. *a* is the pressing-roller lever having at one end a hook *b* from which a weight is suspended. The lever is pivoted to an eye bolt *c* which is adapted to be secured to the grating of the spinning frame. The other end of the lever is provided with a forked bolt *d* pivoted thereto. *e* is a stirrup, the ends *f* of which are adapted to press on to the stationary member of the pressing-roller bearings. The stirrup is provided with pins *g* adapted to rest on the gratings and the arch of the stirrup is slotted to receive the forked bolt *d*. A strap *h* is provided on the stirrup by which it may hang on the lever when displaced for removing the roller. An adjustable nut *k* is provided on

Fig. 1.

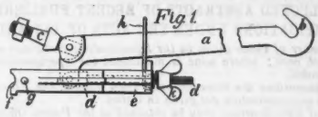
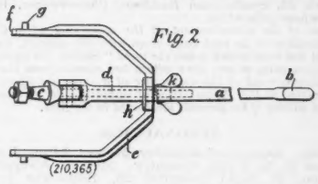


Fig. 2.



(210,365)

the bolt *d*. The mechanism allows the adjustment for wear to be made while the machine is running. In operation, the pressure from the weighted lever is applied to the pressing roller through the stirrup which engages with the stationary part of the bearing, and friction at the points of pressure is avoided. (*Sealed.*)

MISCELLANEOUS.

210,522. R. L. Owens, Liverpool. Heat-Insulated Chambers. (11 *Figs.*) November 1, 1922.—The invention relates to a receptacle or chamber, particularly for use in cold storage. A chamber, according to the invention, is constructed in sections so formed and connected together that, after having been erected in one place, the chamber may be readily taken down, removed, and re-erected in another position by unskilled or semi-skilled labour without impairment of its insulating efficiency. *a* is an upright or key piece of wood which is equal in length to the height of the sides of the chamber; in a corner face of the uprights are formed two steps *a*1, *a*2, in which are disposed ends of layers *b*, *b*1, respectively, of tongued and grooved boards, such layers constituting one member of a double wall of a chamber, the ends of the wall layers *b*, *b*1 being cut or stepped as shown, so that they will lie snugly on the steps *a*1, *a*2. The diagonal corner of the upright *a* is stepped at *a*3, *a*4, and on these steps there are disposed ends of tongued and grooved layers *c*, *c*1 forming the outer member of a double chamber wall. In the inner corner of the upright *a* there is formed a step *a*5 which is parallel with the steps *a*3, *a*4, and on which step *a*5 is disposed an end of a wall layer *d* whereto is secured a second layer *d*1, the two layers constituting an inner member of the double side wall *c*, *c*1, *d*, *d*1. There is provided a second upright *e* of length equal to that of the upright *a* and which upright *e* is disposed on the inner side of the upright *a* and abuts against same. On the inner side of the upright *e* there is formed a step *e*1 on which is disposed an end of a tongued and grooved layer *f* whereto is secured a second layer *f*1, said two layers constituting the inner member of the double wall *b*, *b*1, *f*, *f*1, the end of the second layer *f*1 abutting against the layer *d* of the wall *d*, *d*1, whilst the adjacent end of the wall layer *d*1 abuts against the adjacent end of

Fig. 1.

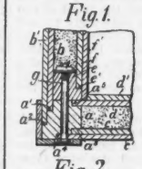


Fig. 3.

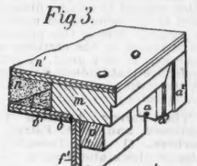


Fig. 2.

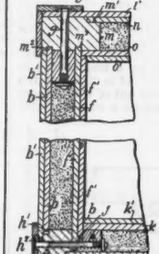
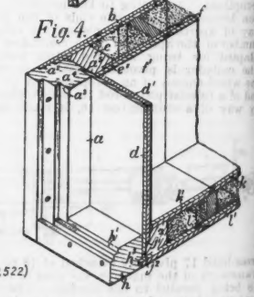


Fig. 4.



(210,522)

the wall layer *f*1. Spaced bolts *g* extend through the parallel key members *a*, *e* and make an effective joint when screwed up. Similar jointing arrangements are provided at the other corners of the chamber walls. A corner jointing of the bottom of the chamber with a side is effected in the following manner:—There is provided horizontally disposed key members *h*, *j* each of which is double stepped at *h*1, *h*2 and *j*1, *j*2 to receive the lower ends of the members *b*, *b*1, and *f*, *f*1 of a side wall. On the upper face of the key member *j*, there are secured, in any convenient manner, ends of layers *k*, *k*1 constituting the floor of a double bottom, and suitably spaced below the floor are the lower layers *l*, *l*1 of the bottom, the inner layer *l* whereof projects into a groove or recess *h*3 formed in the key piece *h*. The corner jointing of the top of the chamber with a side is effected in the following manner:—There is provided a horizontal key piece *m* stepped at *m*1 on which the ends of layers *n*, *n*1 forming the outer member of the double roof wall rest. The inner layer *o* of the roof ceiling member *o*, *o*1 abuts against key piece *m*, the inner layer *b* of the side wall member *b*, *b*1 enters a groove *m*2 of said horizontal key member *m*, and the inner layer *f* of the wall member *f*, *f*1 enters the groove *m*3 of the longitudinal key member *m*. Between the vertical walls *b*, *b*1 and *f*, *f*1 a second longitudinal key member *p* is disposed through which, and the first key member *m* together with the outer part of layer *n*1, bolts *g* extend, which bolts, on being screwed up, effect closure on an extended baffle joint line so created. (*Sealed.*)